

# Multi-Agency Integration of Remote Sensed GOES DCS Telemetered Hydrometeorological Observations

**Satellite Telemetry Interagency Working Group (STIWG)  
Response to  
FCC NPRM docket #19-116  
Allocation and Service Rules for the 1675 – 1680 MHz Band**

# Introduction

- GOES DCS (Geostationary Orbiting Environmental Satellites Data Collection System) Satellite telemetry has revolutionized the collection and integration of environmental data delivering over 8 million observations from more than 40,000 data collection platforms per day, and growing rapidly. Relied on by **more than 600 federal AND non-federal agencies** (e.g., *International Boundary and Water Commission, and Government of Newfoundland and Labrador, Canada*) and entities for relaying vital environmental data, GOES-based telemetry avoids many of the vulnerabilities attributable to terrestrial media (line-of-site radios, telephone lines, cellular towers, etc.) for public weather warnings and alerts; operational decision support; emergency response, coordination and management; and other critical uses. As wireless technology (e.g. cellular/smart phones) has become a viable and pervasive means of communication its continued expansion without proper safeguards threatens to disrupt, impede, and halt the reception of valuable environmental data by earth ground stations.
- As all wireless devices utilize an allocation of spectrum, the separation of devices and moderation of output levels allow the many wireless devices we use today to coexist in the same space. Proposed commercial high output infrastructure to support the nation's growing number of advanced wireless devices is seeking to utilize the same or adjacent radio frequencies as the systems receiving telemetered environmental data. By not implementing appropriate safeguards for the GOES DCS frequencies the protection of life, safety, and property is compromised. The continued protection of the GOES DCS spectrum is essential for ensuring public safety, protection of property, a robust economy, and effective management of natural resources.
- Thorough and unbiased analysis of the 1675 – 1680 Mhz band is necessary and sufficient before recommending any safeguards to protect incumbent GOES DCS Direct Readout Ground Station (DRGS) receive systems from the proposed terrestrial radio infrastructure. If the results of the aforementioned analysis determines that commercial in-band emissions are spectrally incompatible with DRGS systems then it is our position that incumbent users retain primary status, senior rights, and all associated protections.

# STIWG Membership

- US Army Corps of Engineers
- U.S. Geological Survey
- U.S. Bureau of Reclamation
- National Park Service
- U.S. Forest Service
- U.S. Bureau of Land Management
- NOAA (NWS, NESDIS/NCDC, and NOS)
- State, Local, and International groups actively participate and contribute, e.g.,
  - International Boundary and Water Commission
  - Government of Newfoundland and Labrador
  - Mexican Institute of Transportation
  - National Autonomous University of Mexico
  - Parks Canada
  - State of Colorado
  - State of California

# History of GOES DCS and STIWG

- Formed in 1976; Coordinating with NOAA as the Satellite Data Collection System Interagency Working Group (SDCSIWG)
- November 1979: Presidential Directive mandating NOAA to operate the Geostationary Operational Environmental Satellite Data Collection System (GOES DCS)
- 1985: Chartered as STIWG by the Interagency Advisory Committee on Water Data (IACWD) and Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR)
  - Facilitated user coordination with NOAA on use of GOES DCS
- STIWG now sits under the Advisory Council on Water Information (ACWI) and the Office of Federal Coordinator for Meteorology (OFCM)
- Promotes information exchange/sharing of data, research, and development
- Undertakes projects that benefit the GOES DCS community



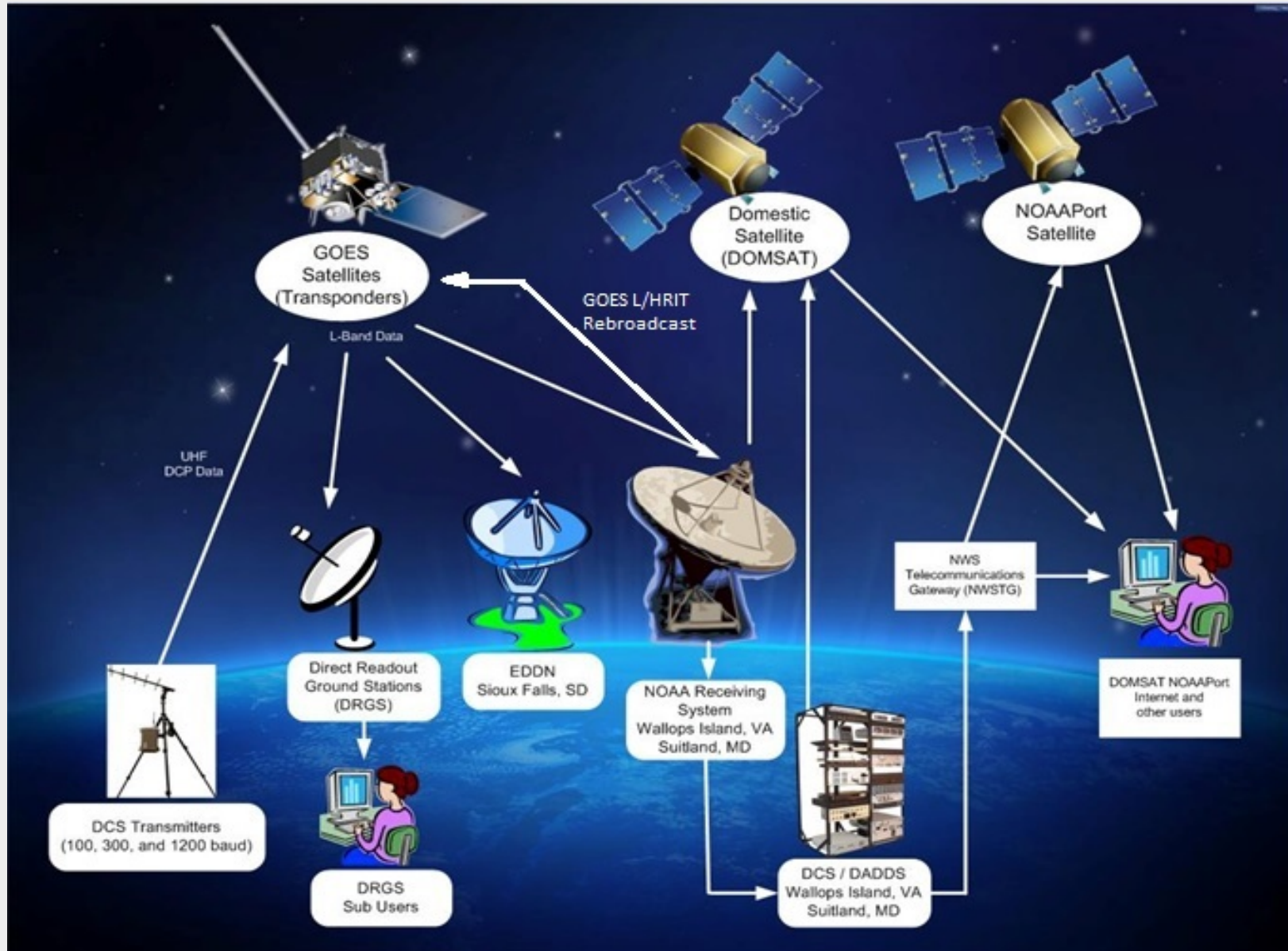
# Working Groups Within STIWG

- DCS Preservation
  - Tasked with addressing issues pertaining to matters that impact the viability, availability, and integrity of GOES DCS data from the GOES satellites.
- OpenDCS Standardization
  - Tasked with establishing an executable plan that will unify existing OpenDCS variants and capabilities into a single platform. The second objective is to establish a way to jointly plan and fund the new platform's development and support by the STIWG agencies.

# What is GOES DCS

- DCS is a data relay capability on the GOES East and West satellites with a channelized downlink operating at 1679.7 – 1680.1 MHz
- Data Collection Platforms (DCP's) deployed in the field collect readings and perform scheduled transmissions to one of the GOES spacecrafts (dependent upon geography) for relay back to Earth ground stations
  - 8 million hydro-met observations are transmitted through GOES DCS each day
  - Direct Read-out Ground Stations (DRGS) collect data directly from the initial GOES relay
  - HRIT DCS is GOES DCS data that is received by processing centers, repackaged, and transmitted to GOES; relayed back to earth for HRIT ground stations with smaller dish antennas to receive
- Stations allocated timeslots to transmit between 300 and 1200 baud
  - Transmissions per hour dependent on assignment: e.g. hourly, half/quarter-hourly, etc.
- GOES DCS is a primary system for many agencies supporting water resource management, navigation, flood control, agriculture, hydro-power, wildfire, etc.

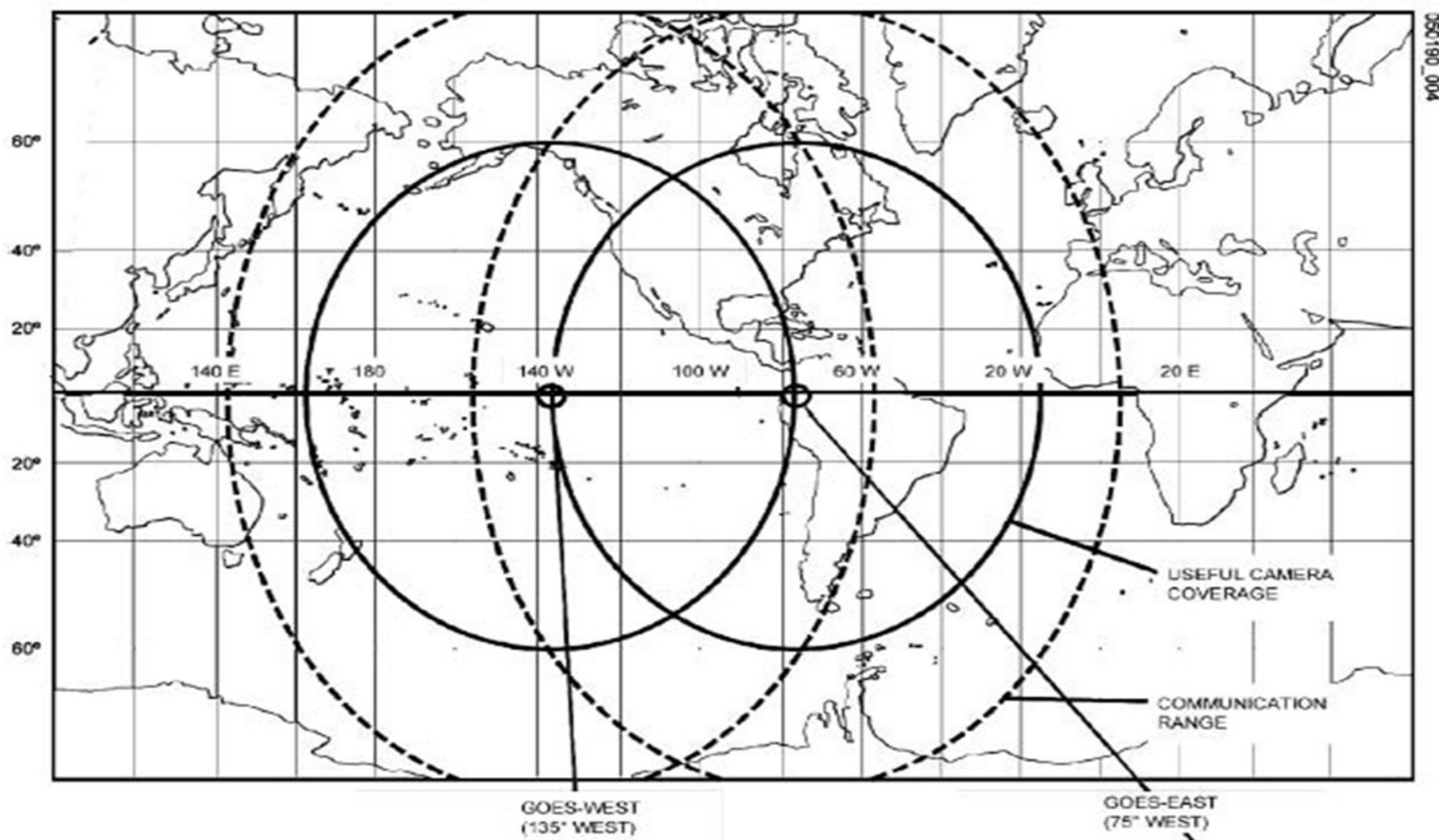
# GOES DCS Principle of Operation



GOES DCS satellites receive transmission from data collection platforms deployed in the field. The messages are relayed from the targeted satellite back to Earth and received by DRGS Earth-stations operated by federal, state, local, and other entities for archival, processing, analysis, modeling, decision support, dissemination, etc. Radio frequency interference in the 1675 - 1680 MHz band will disrupt the GOES DRGS receive systems.

The DOMSAT component of DCS operation has been replaced by GOES High Rate Information Transmission (HRIT) providing a rebroadcast of GOES DCS as well as imagery, bulletins, and other Earth and space weather products through both GOES spacecrafts.

# GOES Footprint



NOAA Satellite and Information Service

National Environmental Satellite, Data, and Information Service (NESDIS)







17,000 location subset of all GOES transmitting sites ingested by the National Weather Service (NWS) Hydrometeorological Automated Data System (HADS) processing over 4.3 million observations daily from 122 Weather Forecast Offices (WFO), 13 River Forecast Centers (RFC), National Centers for Environmental Prediction (NCEP), The National Centers National Operational Hydrologic Remote Sensing Center (NWC NOHRSC), Multi-Radar/Multi-Sensor (MRMS) System for archival at the National Center for Environmental Information (NCEI).

# GOES DCS Data Collection

- Local Read-out Ground Station (LRGS) software suite
  - Network-based tool - e.g. Cove Open-DCS, Sutron DCS-Toolkit
  - Connects to GOES receive systems to ingest, decode, process, QA/QC, validate, transform, store, and disseminate incoming messages
    - Capable of interfacing with other sources
  - Communicates using various protocols (including DAMS-NT) over TCP/IP
  - Various routing options
    - File format: SHEF, SHEF-IT, HydroJSON, Hydromet, Hydstra, etc.
    - Can write directly to various database systems
      - USACE Oracle Corps Water Management System (CWMS)
      - USBR Oracle Hydrologic Database (HDB)
      - Postgres OpenTSDB
      - And others

# GOES DCS Hydro-Met Integration

- Inland Navigation and Water Resource Management
- Operational Decision Support
- Water Quality (TDG, DO, Chlorophyll, PH, turbidity, conductivity....)
- Water Quantity (stage, discharge, storage, snow water equivalent....)
- Flood and Drought Management/Response
- Water Resource Management
- Meteorological (relative humidity, solar radiance, wind vector, air temp....)
- Wildfire Response (RAWS behavior and prediction, BAER post-fire precipitation gages)
- Agriculture (soil moisture, pan evaporation, soil temperature....)
- Academia
- Private Industry/Economic Impacts
- Alerts/Warnings and Information

# US Geological Survey Water Mission Area

- Federally mandated to maintain the National Water Information Program (NWIS) to support collection, processing, review, storage, and dissemination of hydrologic data: <http://waterdata.usgs.gov/nwis>
- USGS streamgages and storm-surge monitors support NOAA flood and severe weather warnings; including hurricanes
- Over 12,000 real-time streamgage sites transmit hydrometeorological and environmental data to the GOES system
  - Weather, flood, and drought forecasting; water resource management; severe storm tracking; meteorology research; and dam, levee and wastewater treatment plant operation and design
  - End-users include hydrologists, seismologists, and geologists for analysis
- Interruption of GOES DCS would diminish the ability of flood fighting agencies
  - US Army Corps of Engineers, US Bureau of Reclamation, states, local, etc.
  - Protection of life, property, and effective water resource management



*The USGS Water Mission Area uses the GOES System for transmission of data from monitoring systems established for Hurricane preparation, river flooding, natural disasters such as landslide and droughts.*

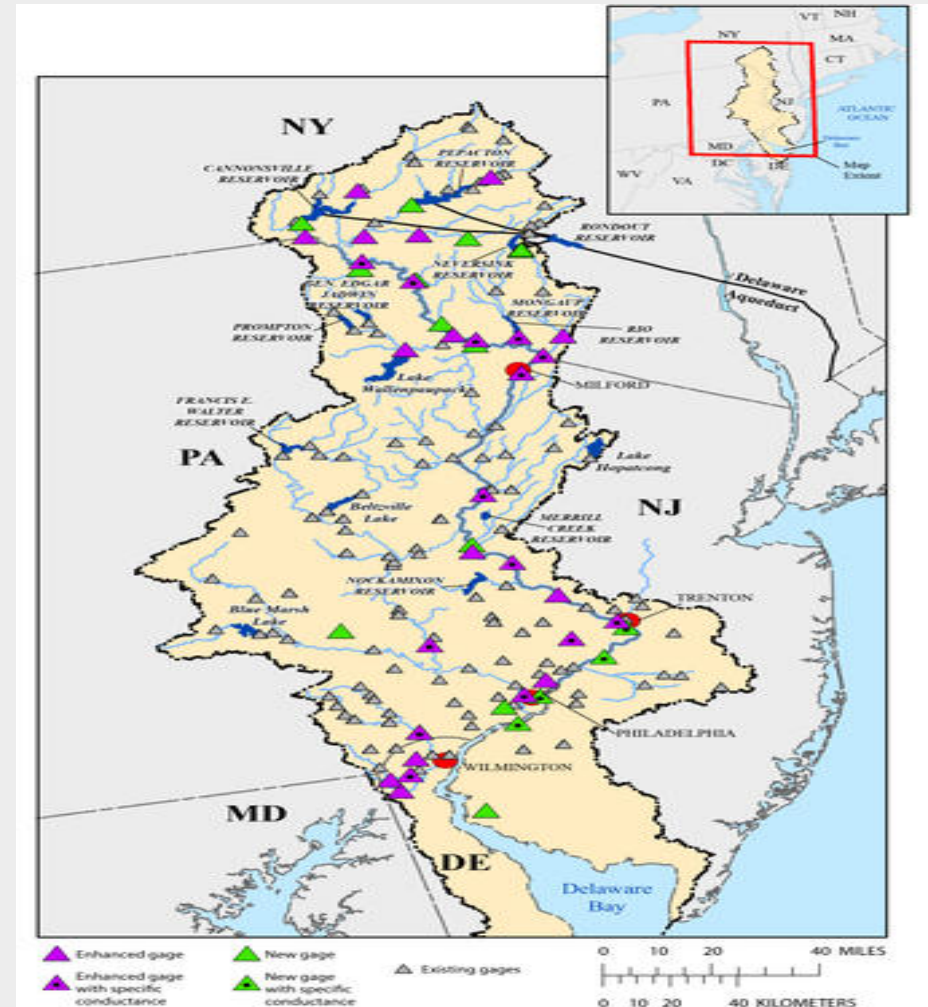
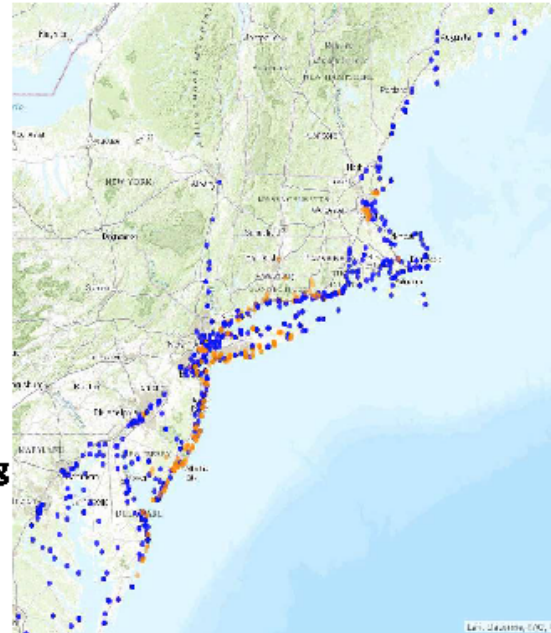




*As preventive measures, USGS WMA has established continuous monitoring networks that use GOES-based data transmissions for hurricane and flood event notification and preparation.*

## Surge, Wave, and Tide Hydrodynamic (SWaTH) Network

- **Entire proposed network consists of about 1,000 sites:**
  - 76 non-USGS stations
  - 162 coastal stations/tidal streams
  - 60 rapid-deployment gages
  - 384 temporary storm-tide sensors
  - 217 temporary wave sensors
  - 102 temporary barometric-pressure sensors
- **Pre-emptive network**
- **Northeast Coast from Virginia to Maine**
- **Nor'easters and tropical storms of varying magnitude**
- **Data distributed through an online mapper termed Short-term Network**



Click to hide News Bulletins

- [Introducing The Next Generation of USGS Water Data for the Nation](#)
- [Full News](#)

# USGS Water Data for the Nation


Search for Sites With Data

Current Conditions

Sites with real-time or recent surface-water, groundwater, or water-quality data.

Site Information

Descriptive site information for all sites with links to all available water data for individual sites.



Map of all sites with links to all available water data for individual sites.

Frequent Searches By Data Category

Surface Water

Water flow and levels in streams and lakes.

Groundwater

Water levels in wells.

Water Quality

Chemical and physical data for streams, lakes, springs, wells and other sites.

Water Use

Water use information.

Introduction

These pages provide access to water-resources data collected at approximately 1.9 million sites in all 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands. Online access to this data is organized around the categories listed to the left.

The USGS investigates the occurrence, quantity, quality, distribution, and movement of surface and underground waters and disseminates the data to the public, State and local governments, public and private utilities, and other Federal agencies involved with managing our water resources.

About Us

Help

Tutorial



# USGS Current Water Data for the Nation

--- Predefined displays ---

Daily stage

Group table by

State

Select sites by number or name

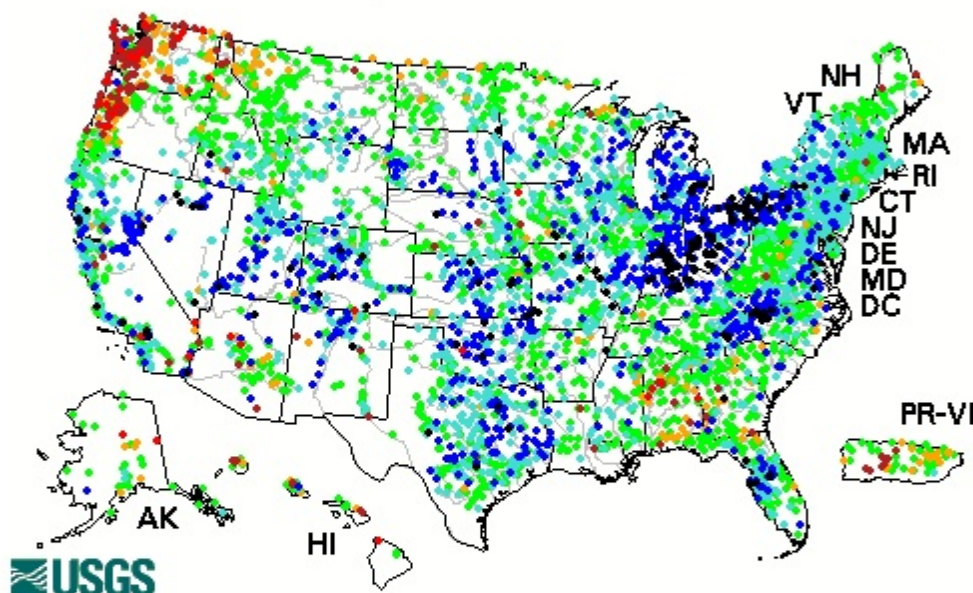
site number

go

show sites on a map

## Daily Streamflow Conditions

Tuesday, June 18, 2019 10:30ET



USGS

### Explanation

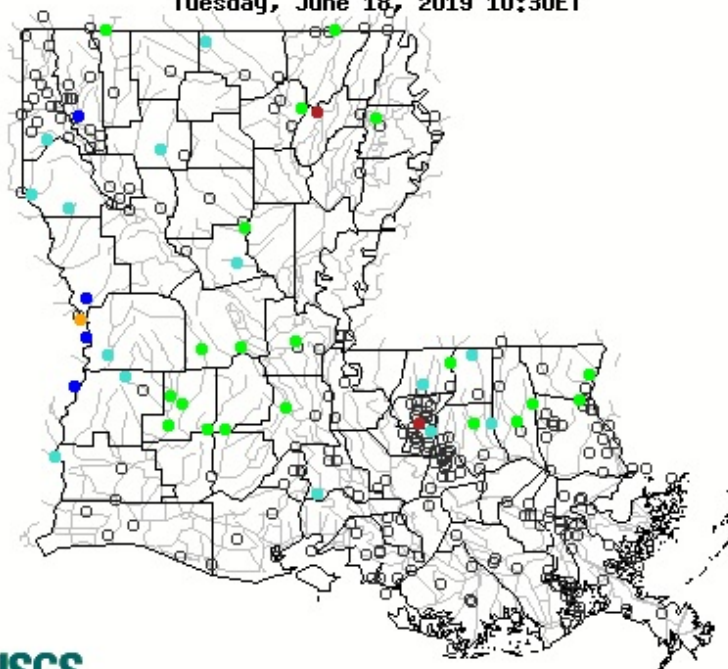
- High
- > 90th percentile
- 76th - 90th percentile
- 25th - 75th percentile
- 10th - 24th percentile
- < 10th percentile
- Low
- Not ranked

The colored dots on this map depict streamflow conditions as a [percentile](#), which is computed from the period of record for the current day of the year. Only stations with at least 30 years of record are used. The **gray circles** indicate other stations that were not ranked in percentiles either because they have fewer than 30 years of record or because they report parameters other than streamflow. Some stations, for example, measure stage only.

## Daily Streamflow Conditions

Select a site to retrieve data and station information.

Tuesday, June 18, 2019 10:30ET



### Explanation

- High
- > 90th percentile
- 76th - 90th percentile
- 25th - 75th percentile
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## Gage height, feet

Most recent instantaneous value: -0.37 06-18-2019 10:00 CDT

USGS 07377500 Conite River near Olive Branch, LA



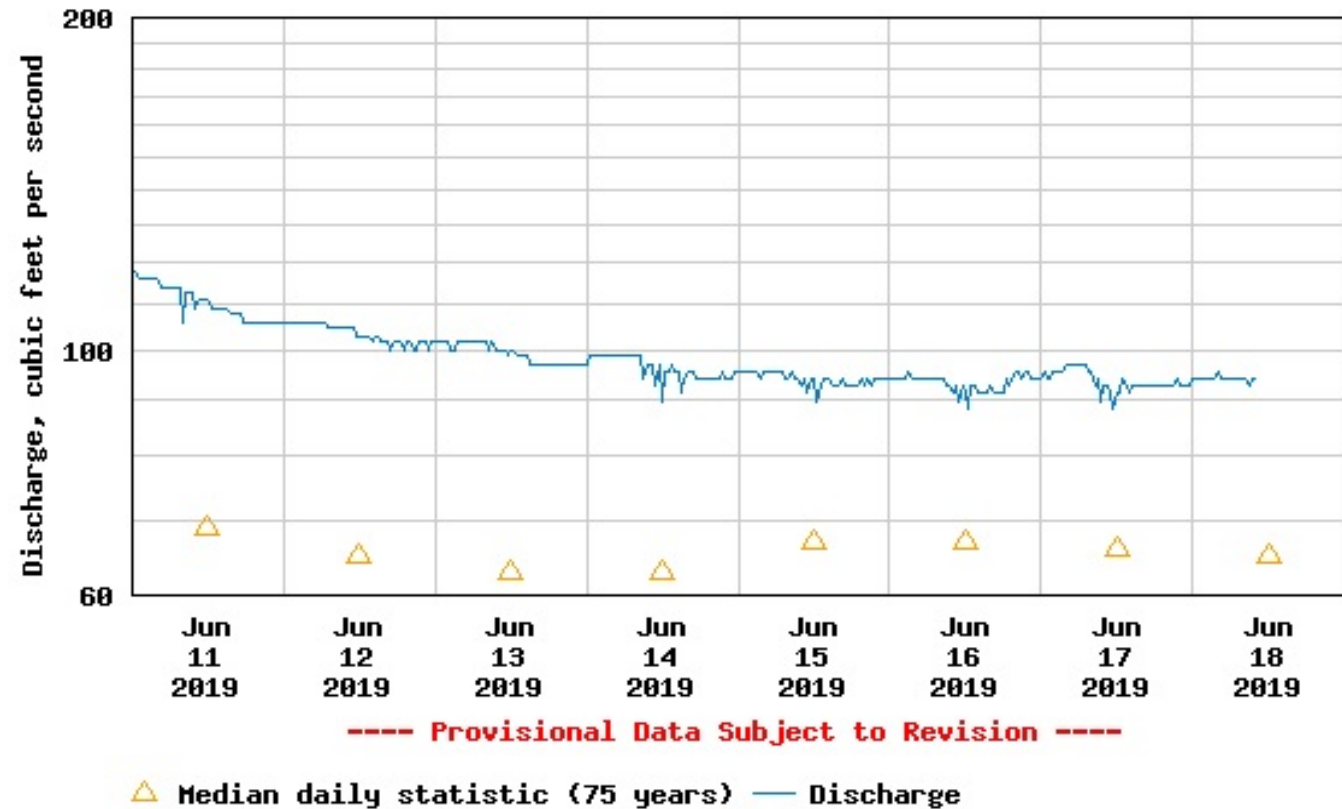
---- Provisional Data Subject to Revision ----

Create [presentation-quality](#) / [stand-alone](#) graph. Subscribe to [WaterAlert](#)

## Discharge, cubic feet per second

Most recent instantaneous value: 94.3 06-18-2019 10:00 CDT

USGS 07377500 Conite River near Olive Branch, LA

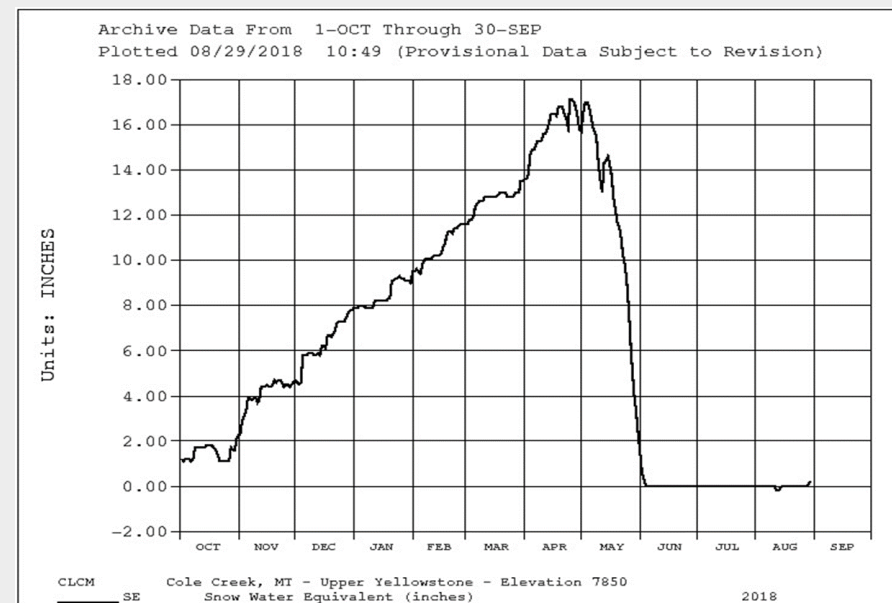
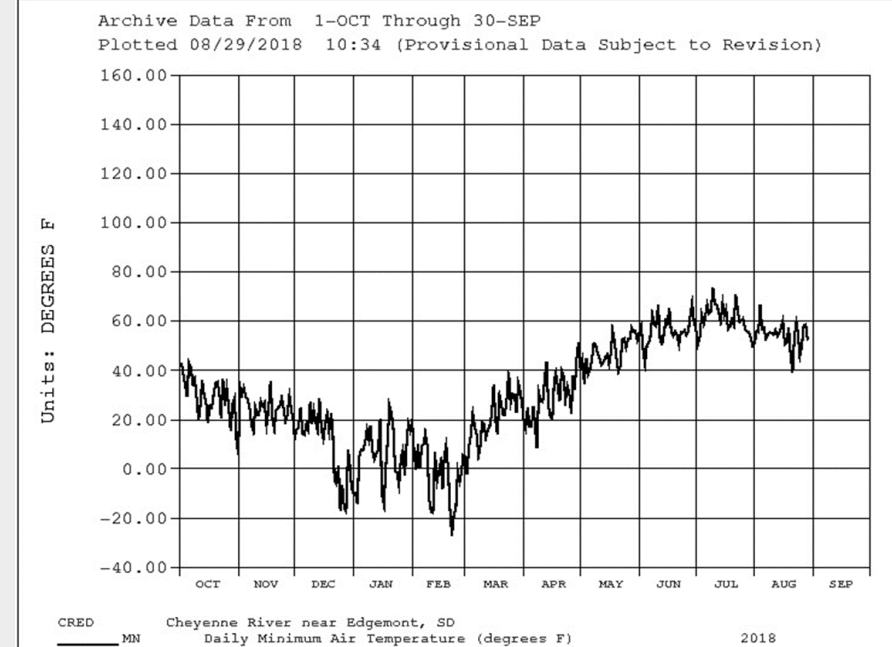
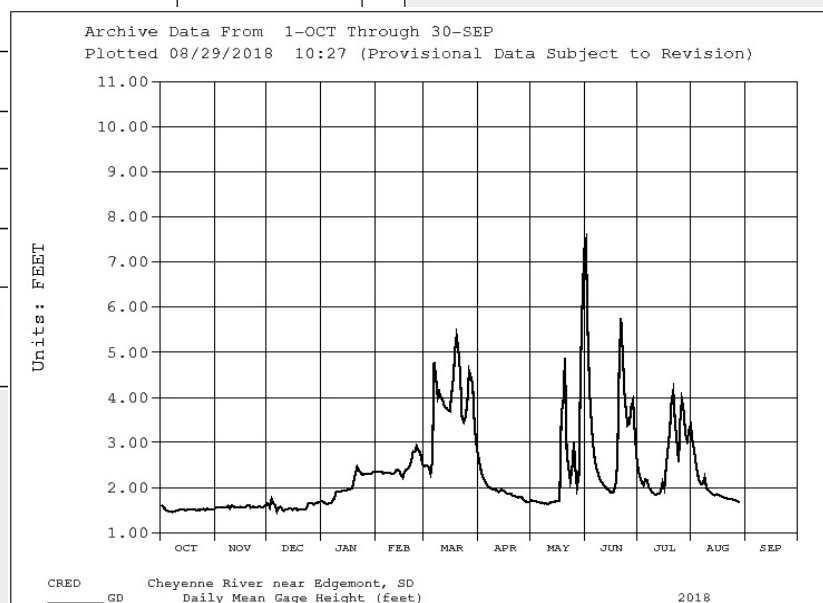
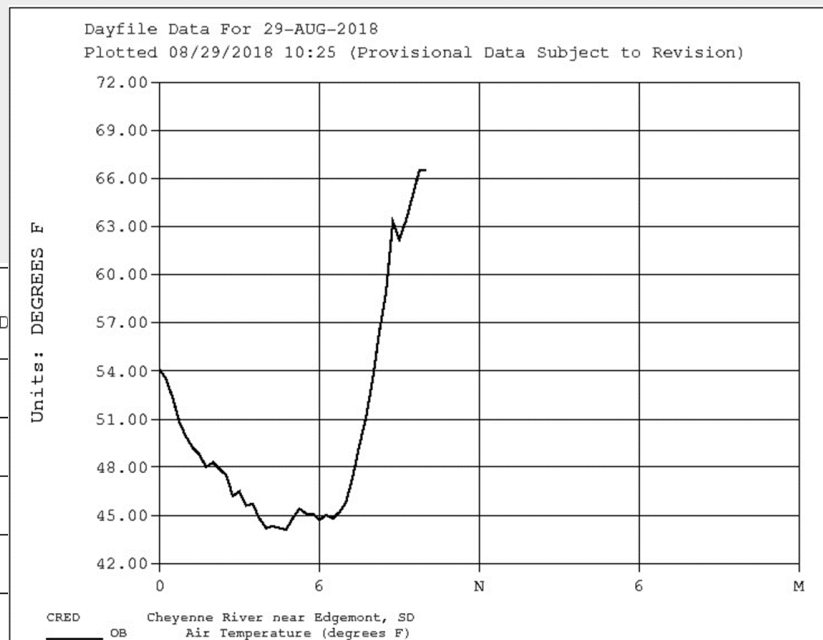
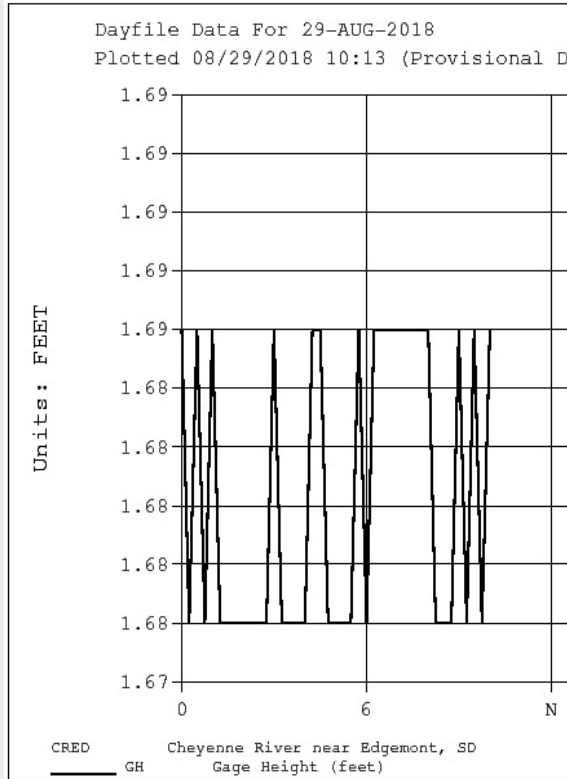


Create [presentation-quality](#) / [stand-alone](#) graph. Subscribe to [WaterAlert](#)

# US Bureau of Reclamation River Levels, Reservoir Capacity and Snow Water Equivalence

- USBR is the largest wholesale water supplier in the United States
  - Supplies 31 million people (10 trillion gal/year)
- Second largest supplier of hydro-power (\$1B+/year, 3.5M homes)
- Operates 600+ Water Management Projects in the Western United States
  - Flood control
  - Recreation (280+ recreation sites)
  - Fishing
  - Wildlife benefits
  - Irrigation (10 million acres: 60% of US vegetables, 25% of nuts)





# CBT - EAST SLOPE

ADATUNCO  
439 cfs

MARYS LAKE (MARYSR)  
Top 927 af, 8040.0 ft  
Current 581 af, 8031.0 ft  
To fill 346 af, 9.0 ft  
Computed Inflow 439 cfs

BTABESCO  
45 cfs

OLYMPUS DAM (OLYDAMCO)  
Top 3068 af, 7475.0 ft  
Current 2655 af, 7472.7 ft  
To fill 413 af, 2.3 ft  
Computed Inflow --- cfs

OLYTUNCO  
452 cfs

BTBLESICO  
47 cfs

PINEWOOD RESERVOIR (PINRESICO)  
Top 2181 af, 6580.0 ft  
Current 1258 af, 6568.7 ft  
To fill 923 af, 11.3 ft  
Computed Inflow 452 cfs

HPCWASCO  
21 cfs

HORSETOOTH RES (HTOOTHRR)  
Top 156735 af, 5430.0 ft  
Current 102285 af, 5400.2 ft  
To fill 54450 af, 29.8 ft  
Computed Inflow --- cfs

FLATIRON RESERVOIR (FLARESICO)  
Top 730 af, 5472.8 ft  
Current 634 af, 5470.0 ft  
To fill 96 af, 2.8 ft  
Computed Inflow --- cfs

BTNFDRCO  
--- cfs

CARTER LAKE RES (CARTERCO)  
Top 112230 af, 5759.0 ft  
Current 67679 af, 5716.8 ft  
To fill 44551 af, 42.2 ft  
Computed Inflow --- cfs

BTCANYCO  
--- cfs

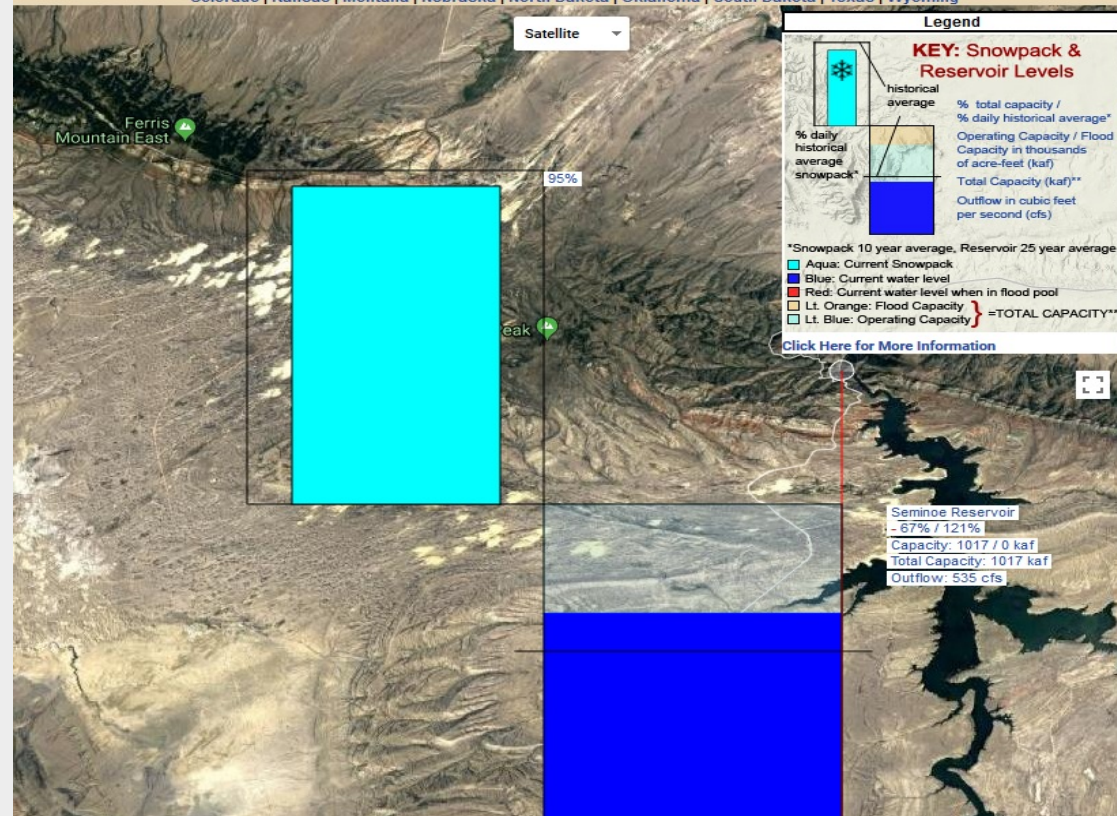
Data as of 08/28/2018



## Snowpack & Reservoir Levels, Great Plains Region

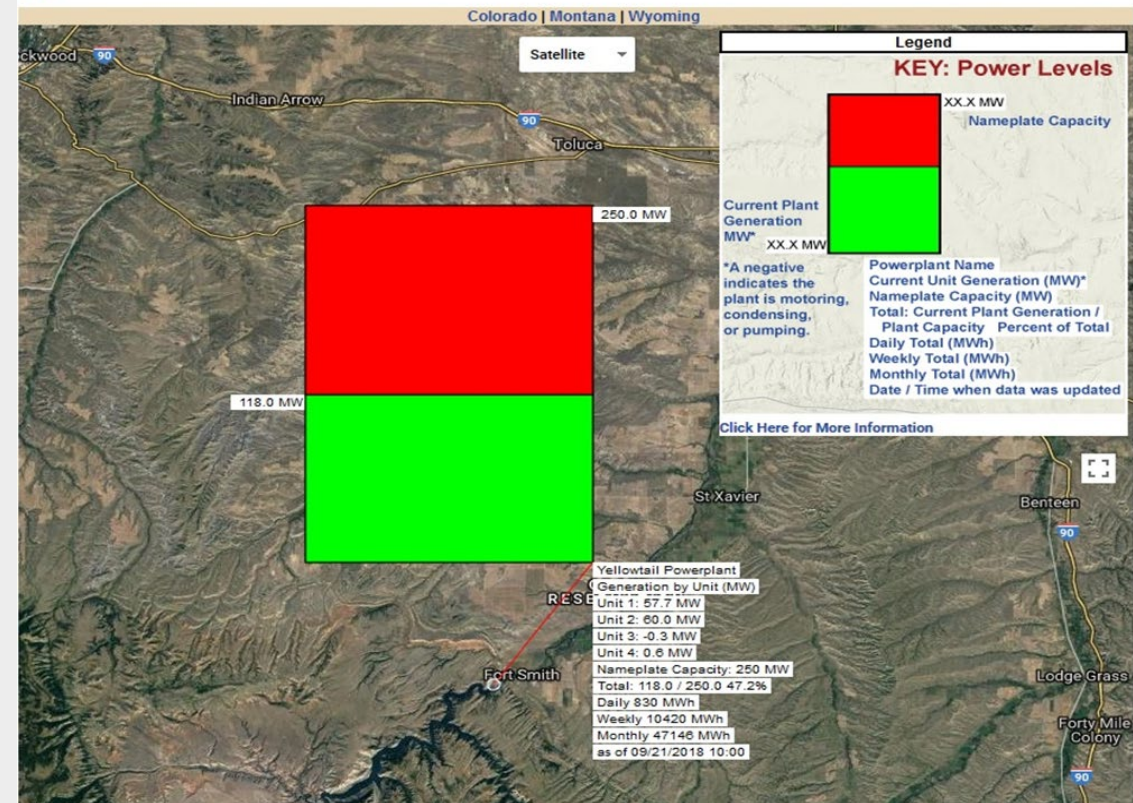
Use mouse to navigate map or use controls to zoom in/out, change orientation, or change map style. For explanation of graph, see legend in the upper-right corner of the map, or [View full legend and associated water operations links](#).

[Colorado](#) | [Kansas](#) | [Montana](#) | [Nebraska](#) | [North Dakota](#) | [Oklahoma](#) | [South Dakota](#) | [Texas](#) | [Wyoming](#)



## Power Levels, Great Plains Region

Use mouse to navigate map or use controls to zoom in/out, change orientation, or change map style. For explanation of graph, see legend in the upper-right corner of the map, or [view the full legend and associated explanation of legend labels](#). [View the Accessible version of the Power Levels Page](#)



# National Ocean Service Tides and Currents PORTS Program

- Physical Oceanographic Real-Time System
  - <https://www.nws.noaa.gov/om/marine/ports.htm>
  - Network of U.S. coastal hydro-met stations located in seaports
    - Measure and disseminate real-time current data, storm forecasts/warnings, water quantity/quality, hydro-met, etc.
    - Proven reliability providing data during extreme storm events
  - Supports safe and efficient coastal navigation
    - Provides mariners with accurate oceanographic data
      - Safety: Reduces collisions and groundings by 60%
      - Maximize cargo load/draft generating increased revenue (as much as \$290K add'l profit/ft of draft)
      - Minimize maritime passage times
      - Protect coastal resources and habitat: ~\$7B annual revenue from saltwater fishing
      - Customizable PORTS composite plots
  - Customized for local requirements
    - Station instrumentation consists of as many as 50 sensors
  - PUFFF – Ports Uniform Flat File Format
    - Enables automated access to PORTS data via well-defined ASCII flat-file exchange specification

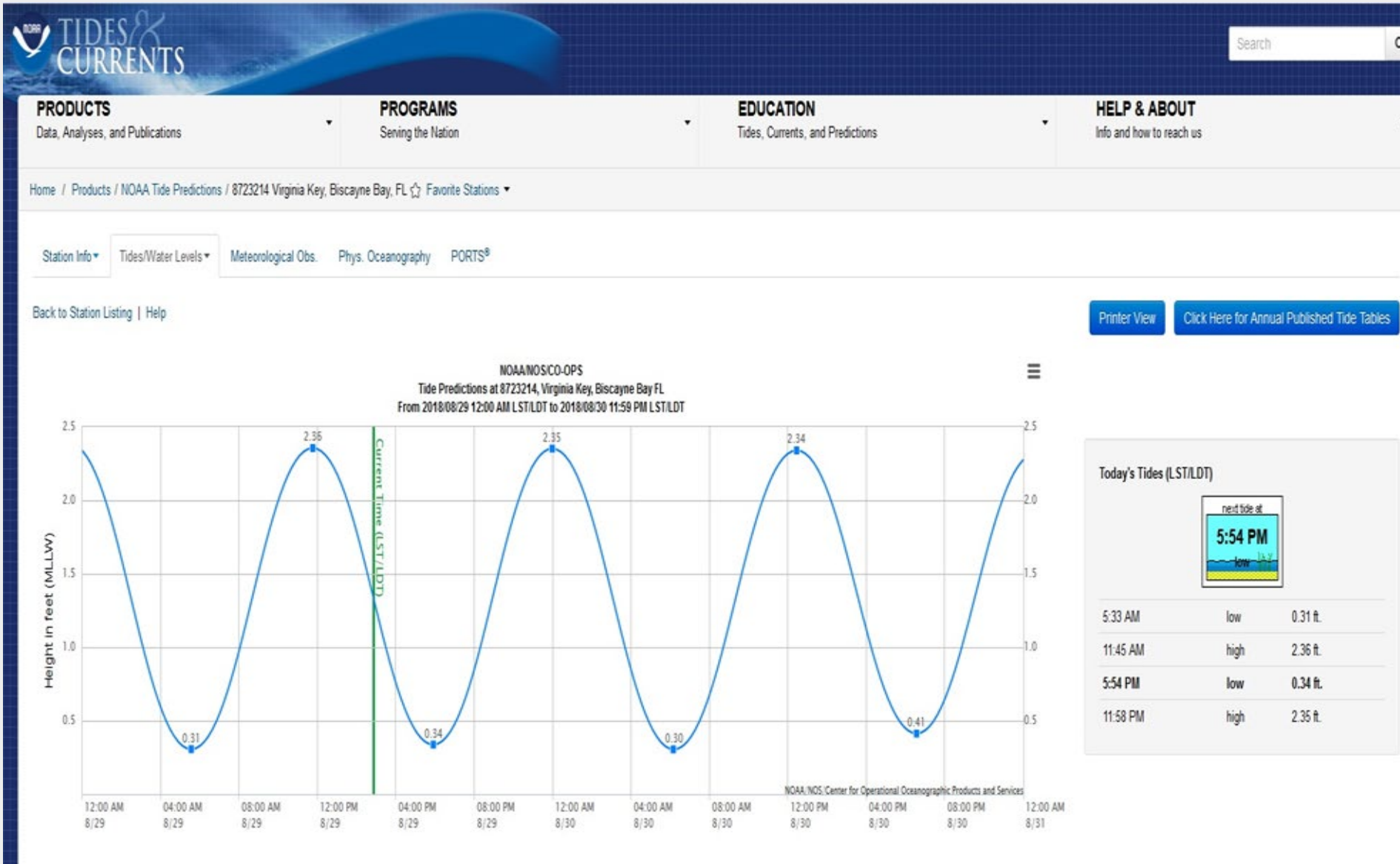


NOS PORTS Program principle of operation. DCP's receiving observations from acoustical Doppler current profilers (ADCP's), anemometers, and other hydro-met instrumentation; transmits data to GOES and over TCP/IP.

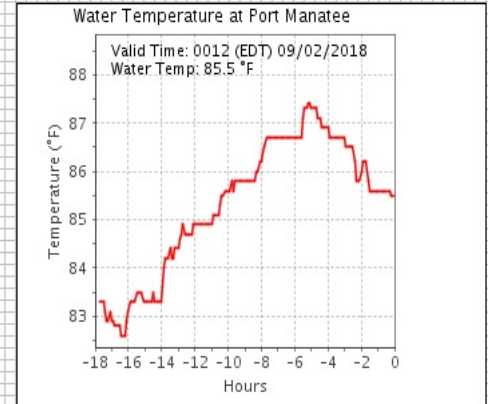
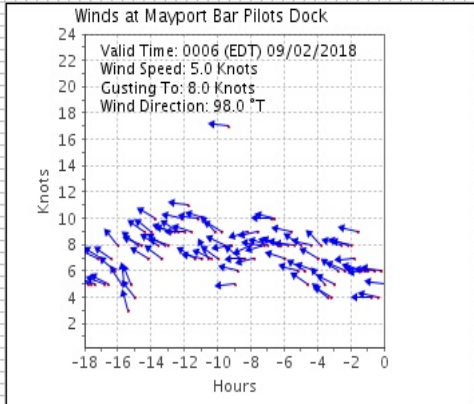
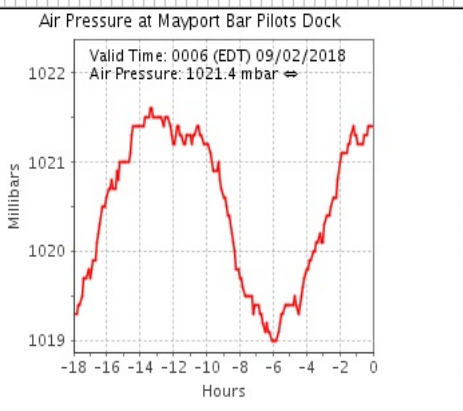
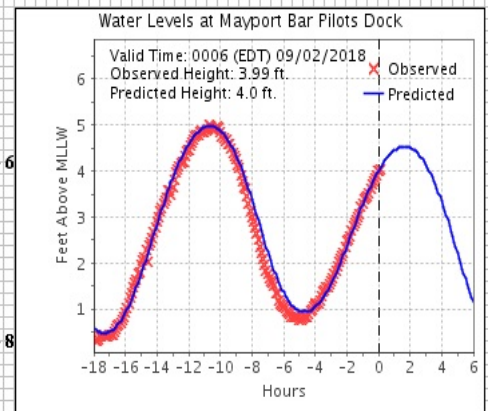
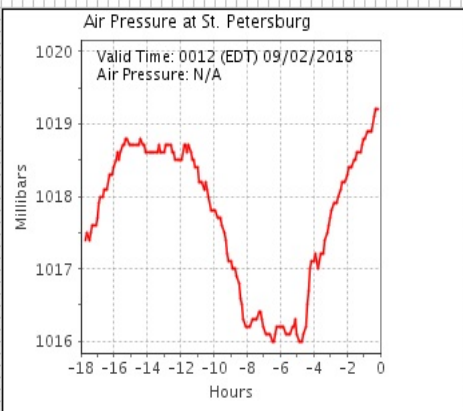
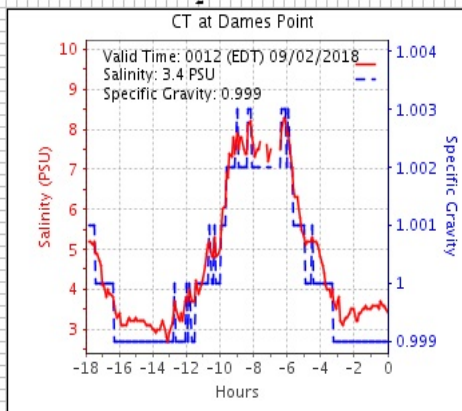
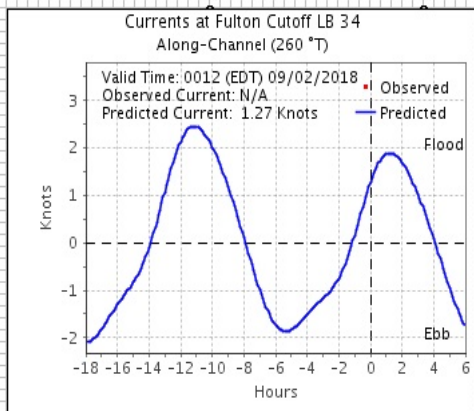
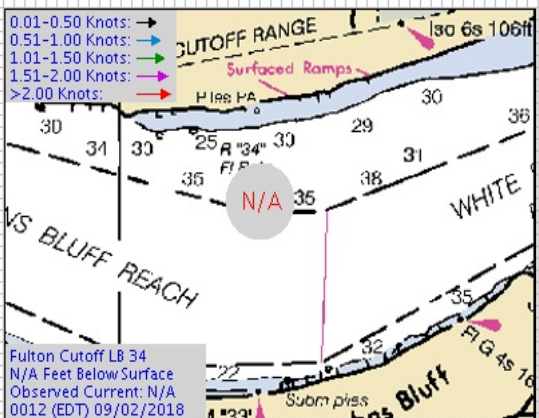
Data is QA/QC'd before dissemination to the public. This system facilitates the safe transport of billions of dollars worth of commerce annually.

Sever storms impede the terrestrial network while GOES telemetry continues to function so long as transmitters and power sources remain viable. See slides 49 – 52 for comparison.






NOS tidal data used by vessel operators to determine the safest time to navigate in certain coastal waters to avoid collisions with overhead structures or running aground risking damage to the ship and aquatic habitat; maritime incidents endanger lives, impact fishing, harm the environment and erode profitability.



- Water Temp
- 8726384 Port Manatee 24hr
- Water Temp
- 8726384 Port Manatee 72hr
- Water Temp
- Baro
- Port Manatee Currents - t03010
- St. Petersburg - 8726520
- Water Levels
- Winds
- Air Temp
- Water Temp
- Baro
- 8726520 St. Petersburg 24hr
- Baro
- 8726520 St. Petersburg 72hr
- Baro
- Met Map
- Old Port Tampa - 8726607
- Makay Bay Entrance - 8726667

# NOAA HAB-OFS Conditions Report

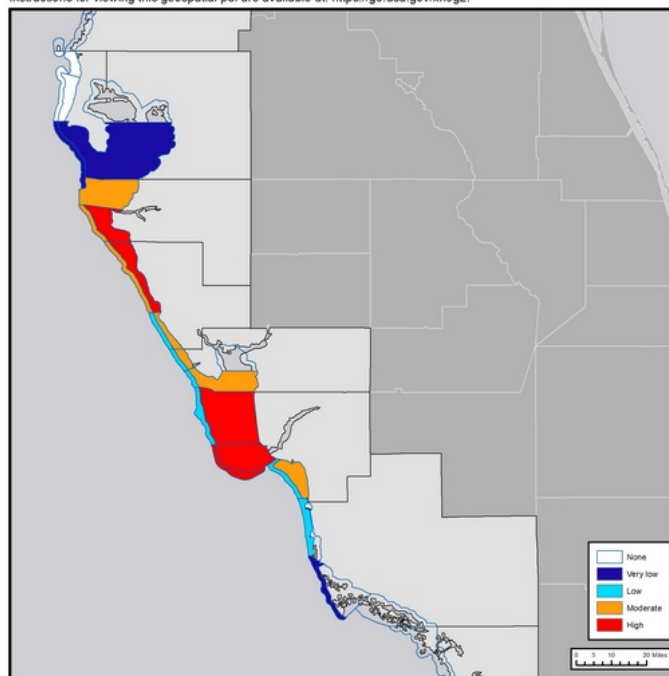
Click on the icon of Adobe Acrobat Reader link to download the PDF reader - 



## Gulf of Mexico Harmful Algal Bloom Bulletin

Monday, August 27, 2018  
 NOAA National Ocean Service  
 NOAA Satellite and Information Service  
 NOAA National Weather Service

Instructions for viewing this geospatial pdf are available at: <https://go.usa.gov/xn9g2>.



The image above is the top layer in a series of maps for 08-27-18 to 08-30-18 displaying the highest level of potential respiratory irritation forecasts in each region.

## Region: Southwest Florida



## Conditions Report

Not present to high concentrations of *Karenia brevis* (commonly known as red tide) are present along- and offshore portions of southwest Florida, and not present in the Florida Keys. *K. brevis* concentrations are patchy in nature and levels of respiratory irritation will vary locally based upon nearby bloom concentrations, ocean currents, and wind speed and direction.

### Recently Reported Impacts (Listed by County):

**Respiratory irritation:** Manatee, Sarasota, Lee, Collier  
**Dead fish:** Pinellas, Manatee, Sarasota, Charlotte, Lee, Collier

### Definition of respiratory irritation levels.

RESPIRATORY IRRITATION LEVEL	AFFECTED POPULATION				
	NONE	CHRONIC RESPIRATORY CONDITION	SENSITIVE TO RED TIDE	GENERAL PUBLIC (MILD SYMPTOMS)	GENERAL PUBLIC (INTENSE SYMPTOMS)
None	X				
Very low		X			
Low		X	X		
Moderate		X	X	X	
High		X	X	X	X

## Additional Resources

### Health Information:

**Florida Department of Health:**  
<http://www.floridahealth.gov/environmental-health/aquatic-toxins/red-tide.html>

**Other resources:** <https://go.usa.gov/xQNWp>

### Recent, Local Observations and Data:

**Mote Marine Laboratory Daily Beach Conditions:**

<http://visitbeaches.org>

**Florida Fish and Wildlife Conservation Commission:**

<http://myfwc.com/redtidestatus>

County Region	Mon 08-27-18	Tue 08-28-18	Wed 08-29-18	Thu 08-30-18
Northern PINELLAS County-Gulf Coast	none	none	none	none
Northern PINELLAS County-Bay Regions	none	none	none	none
Southern PINELLAS County-Gulf Coast	very low	very low	very low	very low
Southern PINELLAS County-Bay Regions	very low	very low	very low	very low



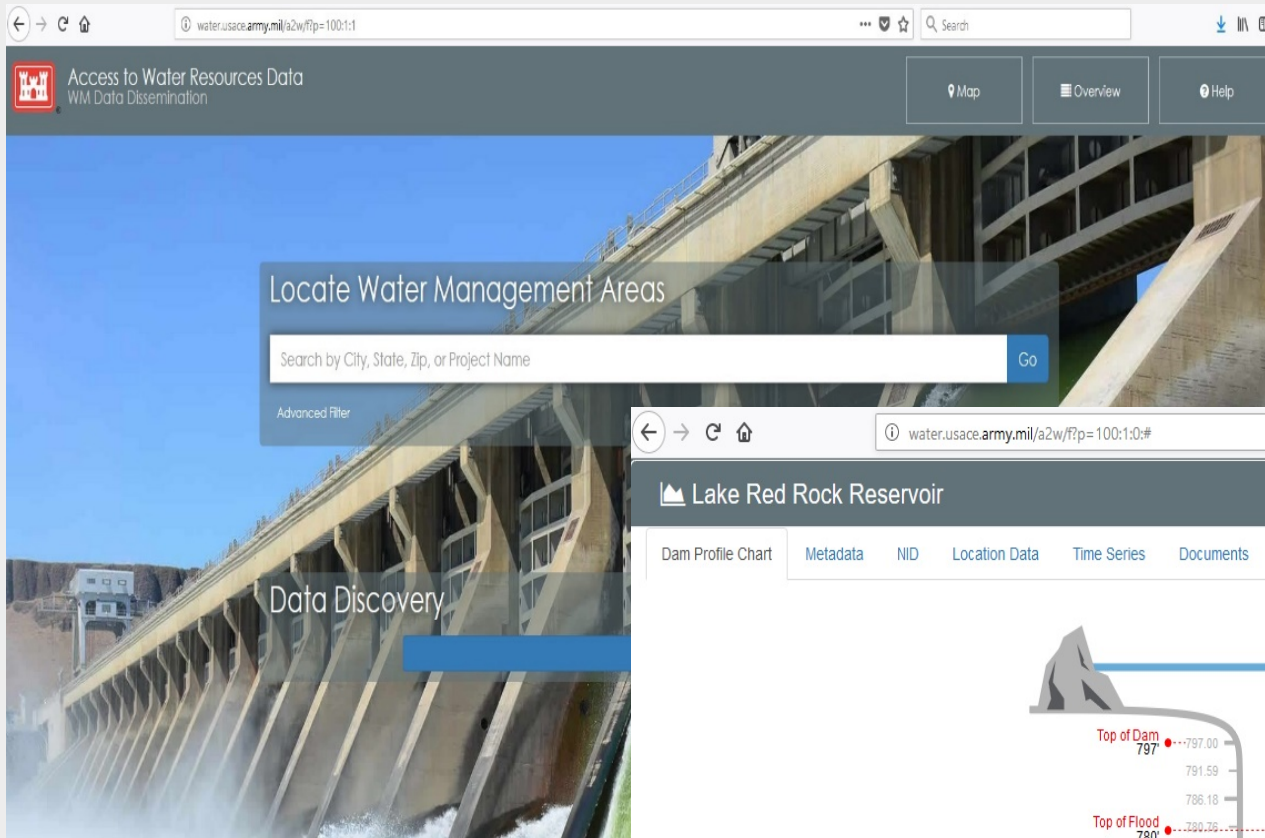
# USACE Effective Flood Control and Navigation Project Operation Benefits

- Real-time GOES data collection, acquisition, archival, decision support, and dissemination
  - Daily/upward reporting, studies, analysis, hydraulic forecasts, operational instructions, etc.
  - Flood Inundation Mapping, Flood Impact Analysis
- Corps Water Management System (CWMS) Modeling
  - Flood Impact Analysis
  - Flood Inundation Mapping
  - Flood Impact Assessments/Calculate Damages
- Provide daily operational forecasts/reports
- Daily Lock and dam operation for safe in-land navigation
  - \$8.7 Billion annual transportation savings
  - \$2 trillion in waterborne commerce annually between inland and coastal navigation
  - 191 USACE-owned Navigation Projects; 236 lock chambers
  - 25,000 miles of navigation waterways
- Daily Reservoir discharge operations
  - \$90 billion of average annual flood damages; 90% of average annual potential damages prevented
  - Flood Control and Coastal Emergency Act
  - ~400 USACE-owned Flood Control Projects
  - Flood control, hydro-power, recreation, water supply, irrigation, etc.
- Provide data to the public, private industry, academia, and other agencies

Figure 1.1 – The Inland Navigation System

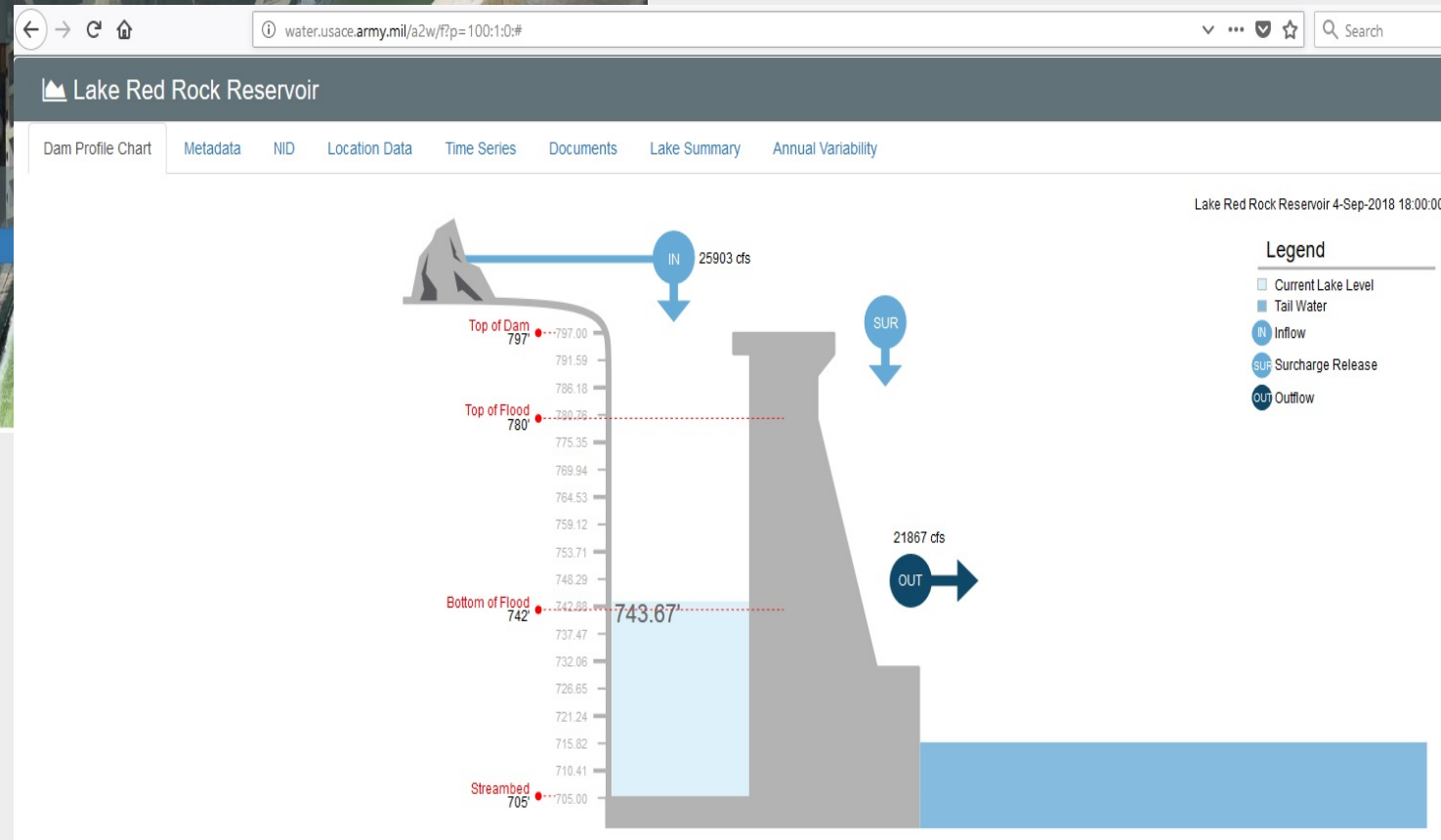


Two basic facts about inland navigation drive this analysis: (1) More than one-half billion tons of freight move an average of 450 miles each year by barge, and (2) There are no better ways to move, store, and otherwise manage this freight. If there were, shippers would choose them. This simple reality forms the basis for the work that follows.

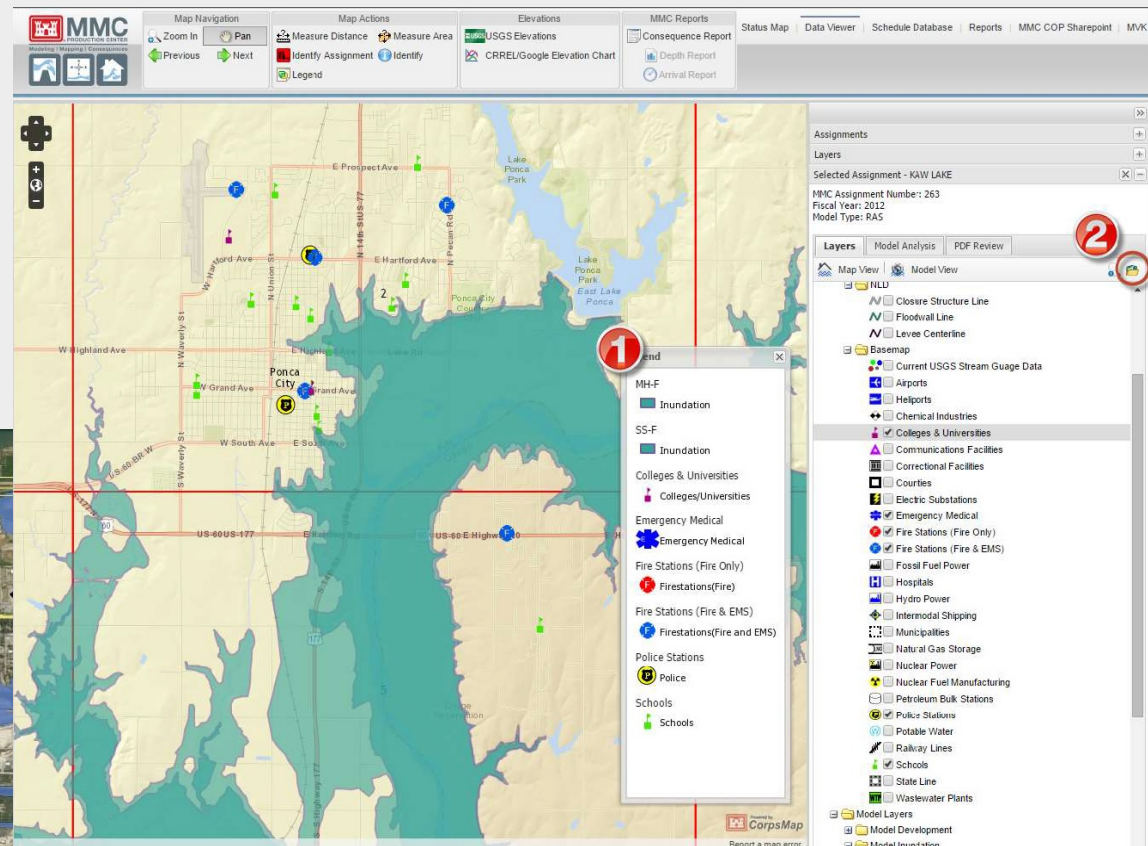
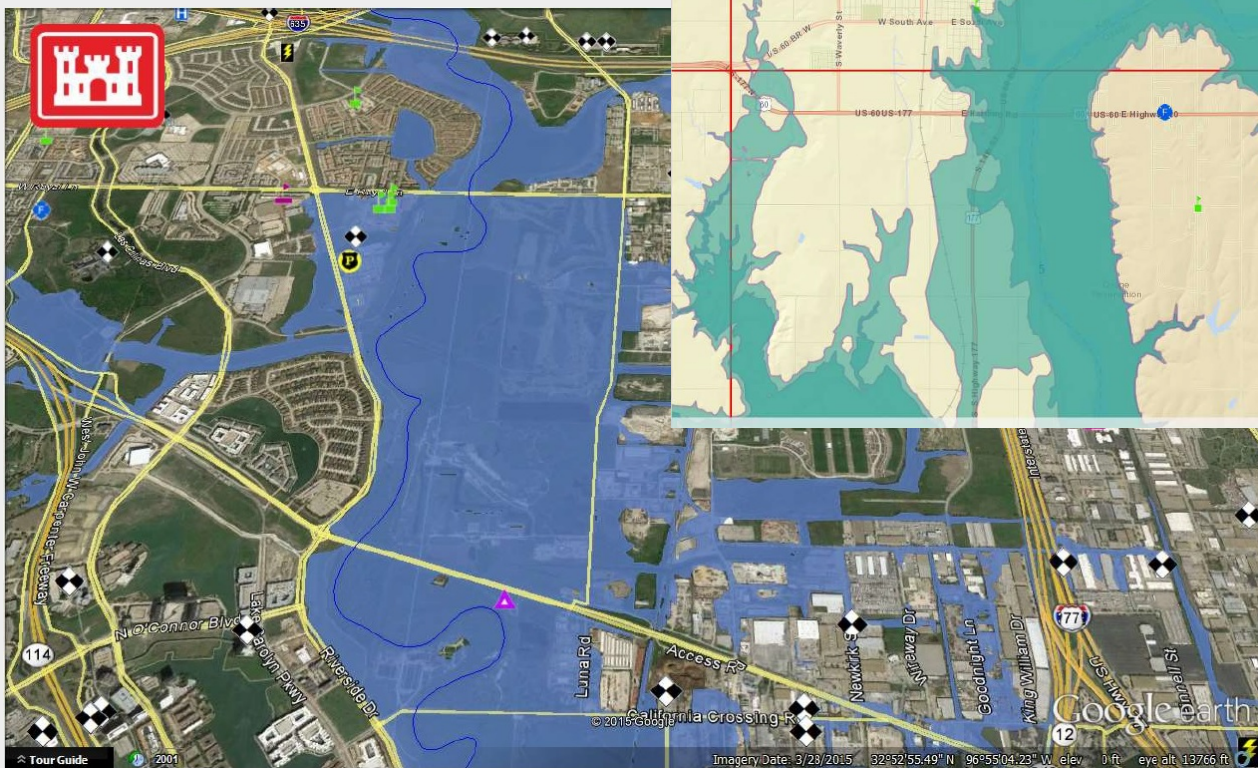


USACE Access to Water provides public access to water resources data; currently includes 425 USACE projects with 1,700 time series e.g., lake elevation, storage, flow, and stage data.

<http://water.usace.army.mil/a2w/f?p=100:1:0:>







USACE Modeling Mapping and Consequences Production Center creates inundation maps by incorporating real-time GOES hydro-met observations. FIM is combined with economic, land use and other information for analysis to estimate consequences/losses; fatality rates, critical infrastructure, real-estate, etc.





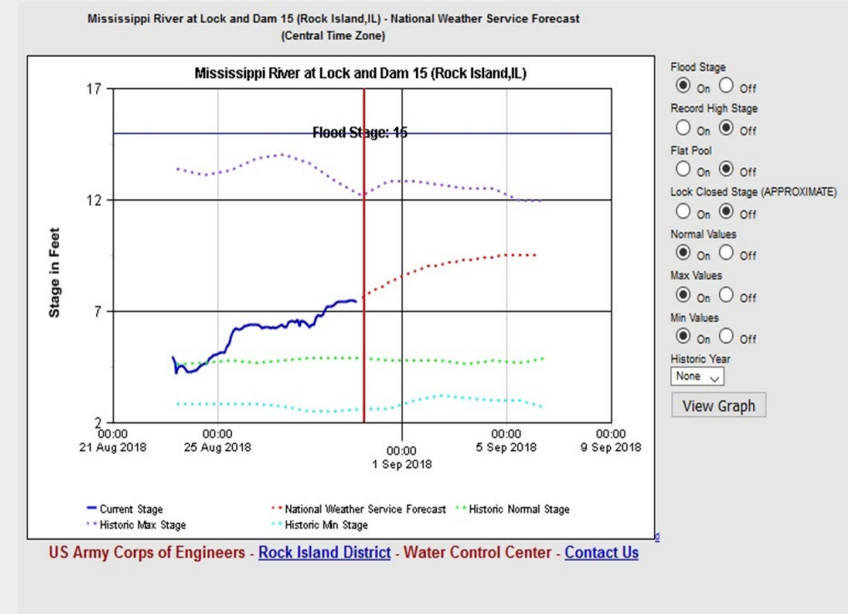
What's This Google Earth Icon All About? Click [Google Earth](#) To Find Out More!

**NOTICE:** All data contained herein is preliminary in nature and therefore subject to change. The data is for general information purposes ONLY and SHALL NOT be used in technical applications such as, but not limited to, studies or designs. All critical data should be obtained from and verified by the United States Army Corps of Engineers. The United States Government assumes no liability for the completeness or accuracy of the data contained herein and any use of such data inconsistent with this disclaimer shall be solely at the risk of the user.

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USACE RiverGages is a public web application providing access to GOES transmitted hydro-met observations. RiverGages is used for operational decision support and heavily visited during flood events.

<http://rivergages.mvr.usace.army.mil>



**RIVERGAGES.COM**  
Water Levels of Rivers and Lakes

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Water Levels By:

National Weather Service Products

Bookmark

☒ View Real-Time Stations In This Basin ☐ View All Stations In This Basin

☒ View All Values In Stage ☐ View All Values In Elevation

[Google Earth](#)

STATION	RECORD STAGE	FLOOD STAGE	LATEST LEVEL	24 Hr CHANGE	24 Hr PRECIP
Cedar River at Lansing, MN as of 10:00	23.44 09/15/2004	18.00	9.31	-0.07	M
Dobbins Creek at Austin, MN as of 10:00	19.18 07/10/2000	11.50	6.68	-0.04	0.00
Turtle Creek at Austin, MN as of 10:00	14.77 09/16/2004	10.50	2.04	-0.11	0.00
Cedar River near Austin, MN as of 10:00	25.00 09/16/2004	15.00	3.22	-0.07	0.01
Turkey River at Spillville, IA as of 10:00	20.25 08/24/2016	16.00	4.89	-0.31	0.00
Turkey River near Eldorado, IA as of 10:00	21.46 06/09/2008	12.00	9.31	-1.39	
Turkey River above French Hollow Creek at Elkader, IA as of 09:00	27.77 06/10/2008	12.00	9.50	+1.28	0.00
Volga River at Littleport, IA as of 09:00	25.36 05/17/1990	12.00	4.23	-0.11	0.00
Turkey River at Garber, IA as of 10:00	32.80 05/23/2004	17.00	11.06	+3.23	0.08
North Raccoon River near Sac City, IA as of 10:00	20.14 06/17/1990	13.00	9.51	-0.63	0.00
North Raccoon River near Lanesboro, IA as of 10:00	20.84 12/16/2015	15.00	13.30	+0.30	0.00
North Raccoon River near Jefferson, IA as of 10:00	22.30 06/23/1947	19.00	9.76	+1.38	0.00
Buttrick Creek near Grand Junction, IA as of 10:00		12.00	8.53	+0.31	0.00
North Raccoon River near Perry, IA as of 10:00	23.00 07/10/1993	15.00	10.75	+1.66	0.00

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RiverGages WaterML webservice allows users to query and retrieve data from the RiverGages database for use in their automated information systems. Based on the CUAHSI WaterML model, this information is immediately available for ingest by WaterML enabled automated systems.

# Lock and Dam 15 – Mississippi River

- Navigation project operated by Rock Island District
- Constructed in 1934
  - Worlds longest roller dam at 1,203 ft
    - 9 gates: 100 ft long x 14.3 ft diameter
    - 2 gates: 100 ft long x 16.2 ft diameter
  - Creates Pool 15 along Upper Mississippi River
  - \$3 billion in commodity transportation savings/\$246 million to operate
    - (1 barge = 58 semi-trailers or 15 rail cars)
- Stats
  - Capacity: 100,000 ac-ft
  - Catchment: 88,500 sq mi
  - Chamber length: Two 600 ft lock chambers at 100 ft wide
  - Transit Time: 30 mins
  - Average Annual Tonnage: 20 Million Tons

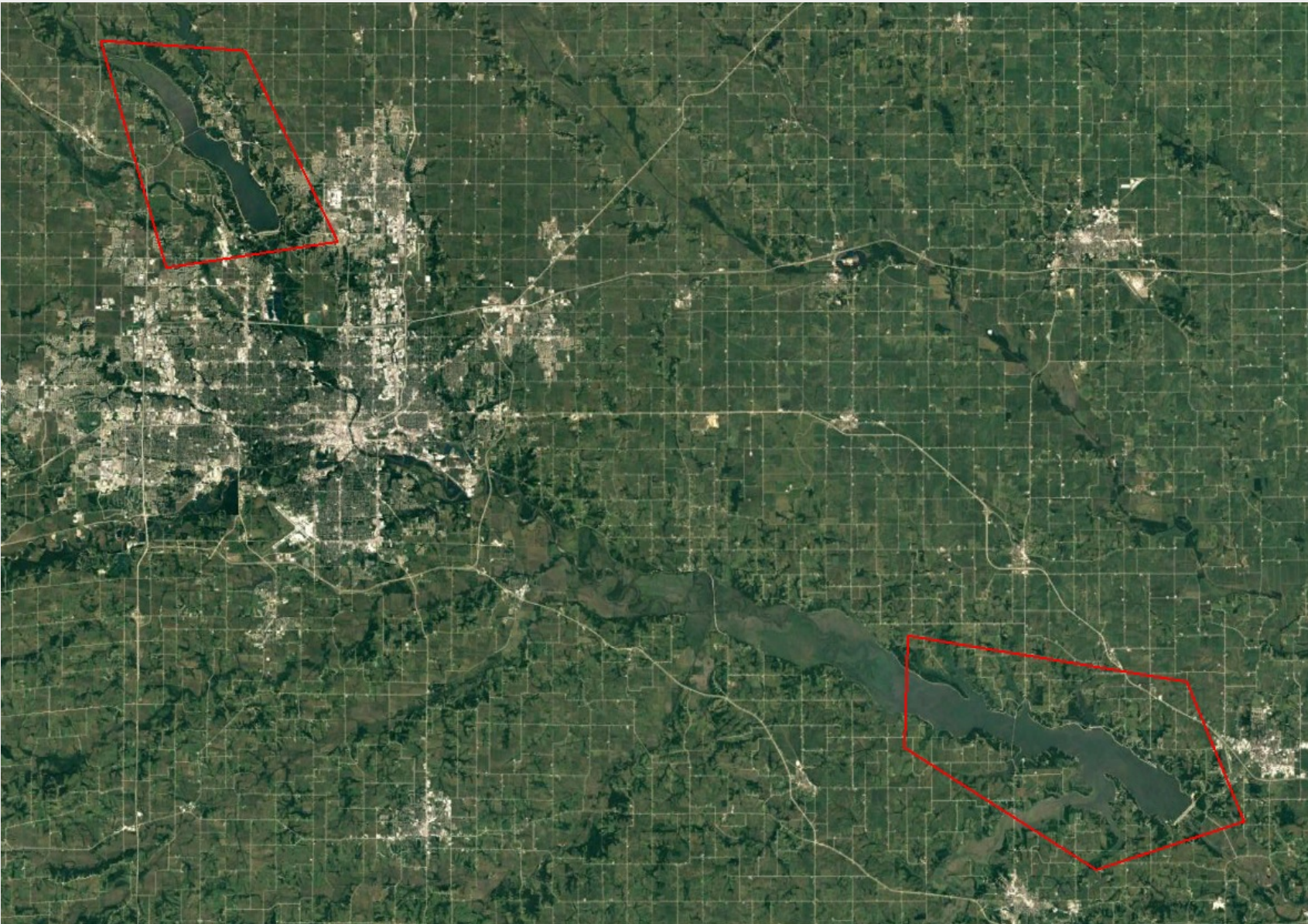






# Red Rock Dam – Des Moines River

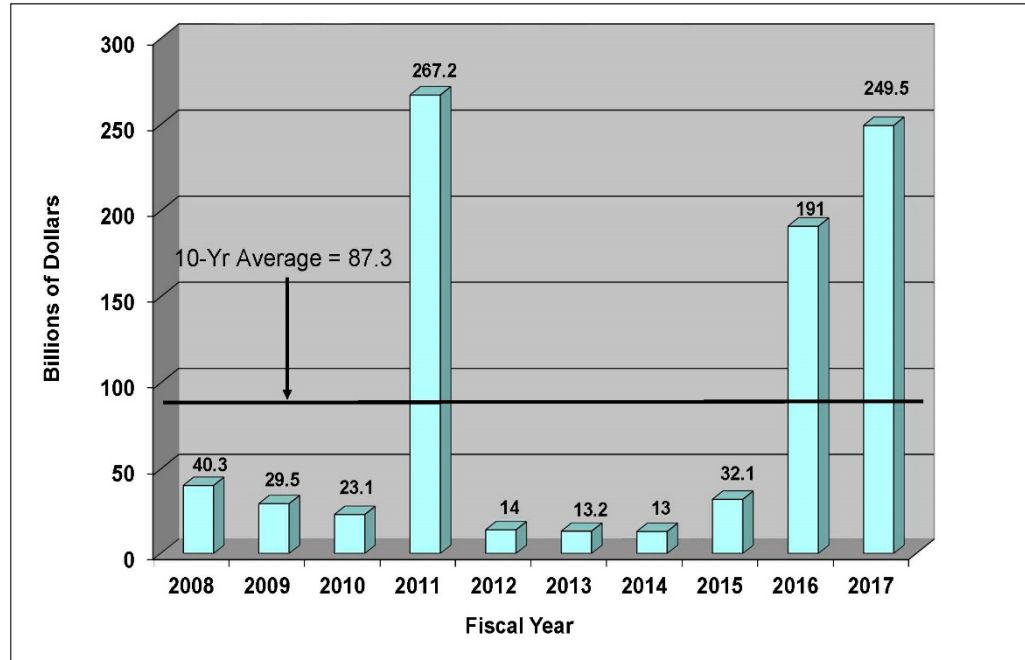
- Flood control project operated by USACE, Rock Island District
  - Operated in conjunction with Saylorville Dam
- Constructed 1960 - 1969
  - Multi-purpose Project
    - Flood control
    - Water supply
    - Recreation: camping, fishing, hunting, etc.
    - Hydro-power (2018)
  - Creates Lake Red Rock in Central Iowa
  - DCP's monitor aiding seasonal conservation pool and drought/flood mitigation operation
- Stats
  - Max discharge: 144,000 cfs
  - Catchment: 12,320 sq mi
  - Length: 5,676 ft, Height: 95 ft, Width: 13.4 ft
  - Surface area: 15,250 acres
  - Power generation (2018): 36.4 MW, (179,000 MWh annually for 18,000 homes)



Saylorville Lake (upper left) and Red Rock Lake (lower right) are operated together during flood events.

FIGURE 1

### Flood Damage Reduction

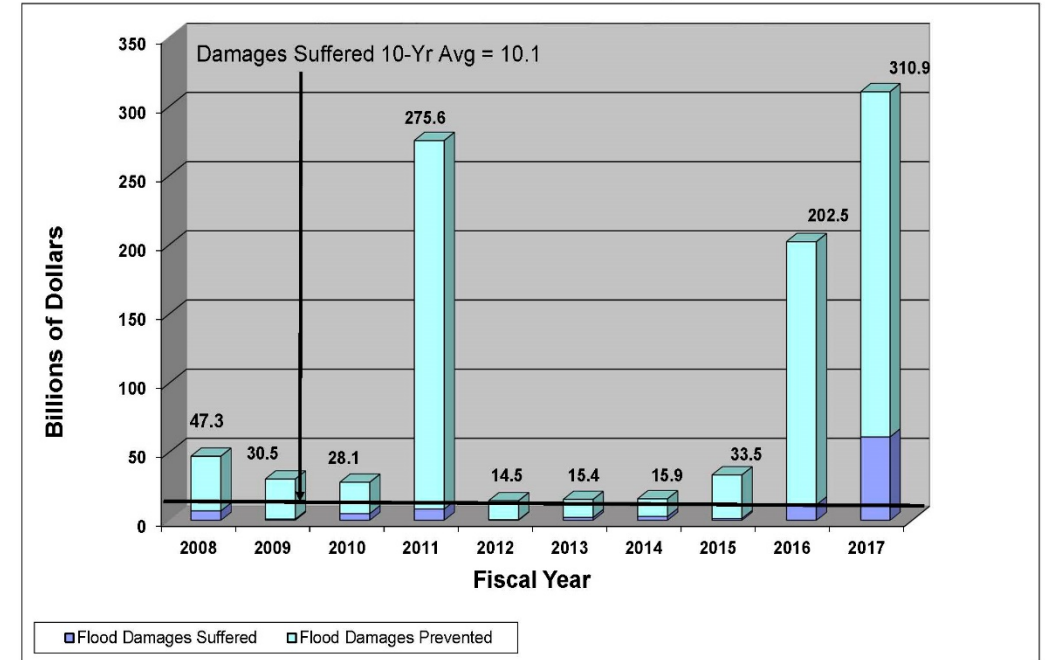


Flood Damages Prevented in the U.S.A. by the U.S. Army Corps of Engineers

G-3

FIGURE 2

### Potential Flood Damages

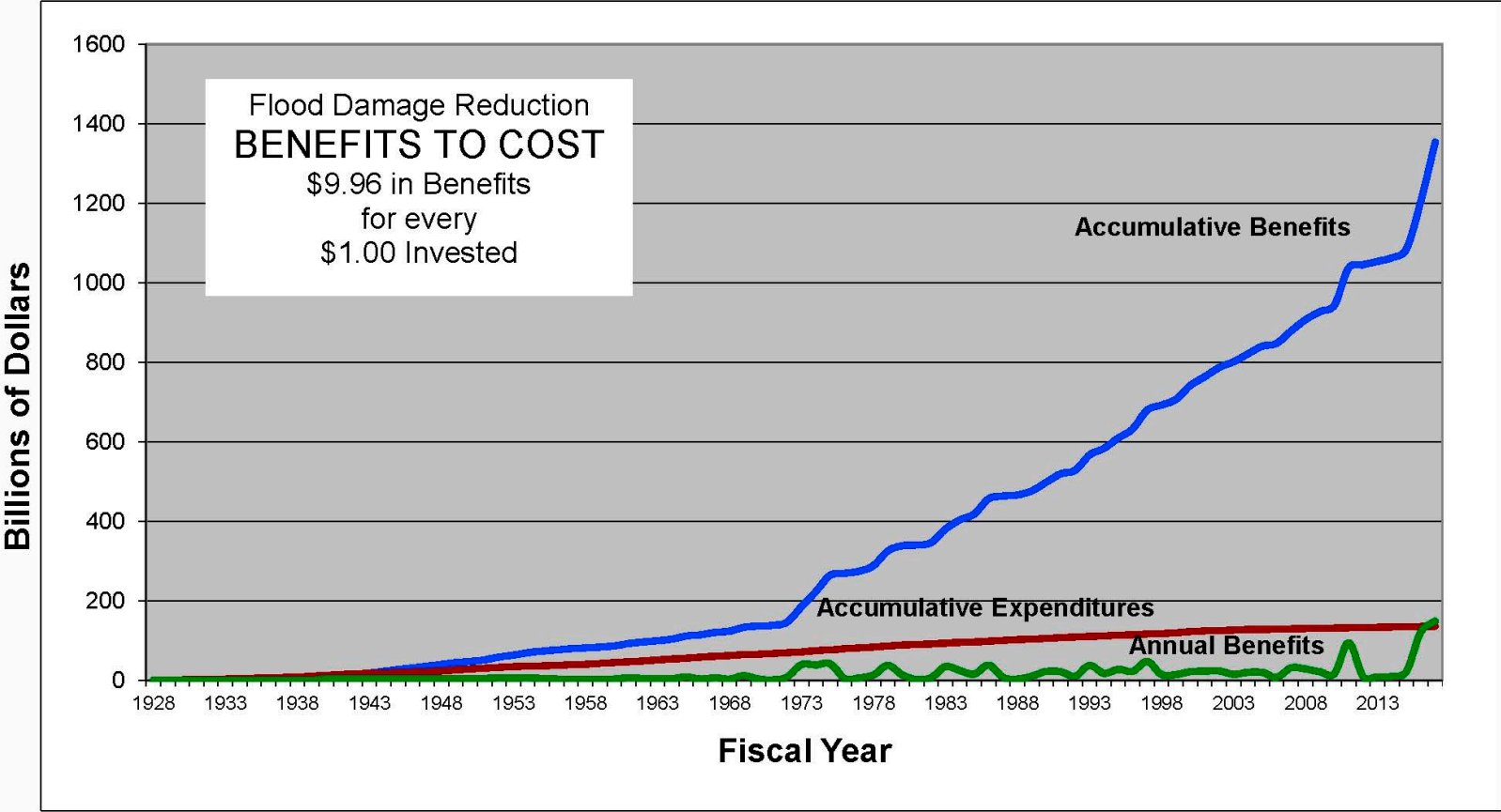


G-4



FIGURE 5

**Benefits of Federal Projects (Damages Prevented)**  
**Accumulative Corps Expenditures (Principle plus O&M)**  
Adjusted to 2000 Using Construction Cost Index EM 1110-2-1304 (Mar 2018 revision)



# Water Quality Mission

- Dissolved Oxygen
- Total Dissolved Gas
- Turbidity
- Conductivity
- Chlorophyll
- Phycocyanin
- Suspended Solids
- Water Temperature
- pH

Real-time Water Quality data provides mission critical information to operate projects within mandated constraints codified in the Water Quality Management Plan unique to each project.

Fish, wildlife, public health, safety, and interest are among the chief tenets for responsible project operation.

# Detroit Dam - Willamette Basin - Salem, OR

- Multi-purpose project
  - Flood Risk Management (operated in conjunction with Big Cliff Dam)
  - Hydro-power generation ( 2 generators producing 100 MW)
  - Water Quality improvement (fish passage improvements)
  - Songbird and waterfowl habitat
  - Recreation
  - Irrigation
- Stats
  - Length: 1,523.5 ft, Height: 463 ft
  - Capacity: 3,500 ac-ft
  - Shoreline: 32 mi, Lake Length: 9 mi



## Detroit Dam & Lake Downstream Passage Project

The U.S. Army Corps of Engineers is conducting an environmental review to aid in developing a project that will provide downstream juvenile fish passage for Upper Willamette River Chinook and temperature control at Detroit Dam. The Detroit Dam and Lake spans the Linn County–Marion County border in the Oregon Cascades on the North Santiam River near the city of Detroit. Read an article about this project [here](#).



### Background

The Corps operates and maintains 13 multipurpose dams and reservoirs (including Detroit Dam and Lake) in the Willamette River Basin in Oregon, collectively referred to as the Willamette Project.

The listing of several species under the Endangered Species Act (ESA) requires the Corps to perform an assessment of the Willamette Project and its operations' impact on listed species. Based on this assessment, the National Marine Fisheries Service (NOAA Fisheries) released a Biological Opinion (BiOp) in 2008 which identified the required actions to avoid jeopardizing the existence of ESA listed fish in the Willamette basin. These include downstream fish passage at Detroit Dam and the minimization of water quality effects, temperature in particular, associated with operations of Detroit and Big Cliff dams, by making structure modifications or major operational changes.



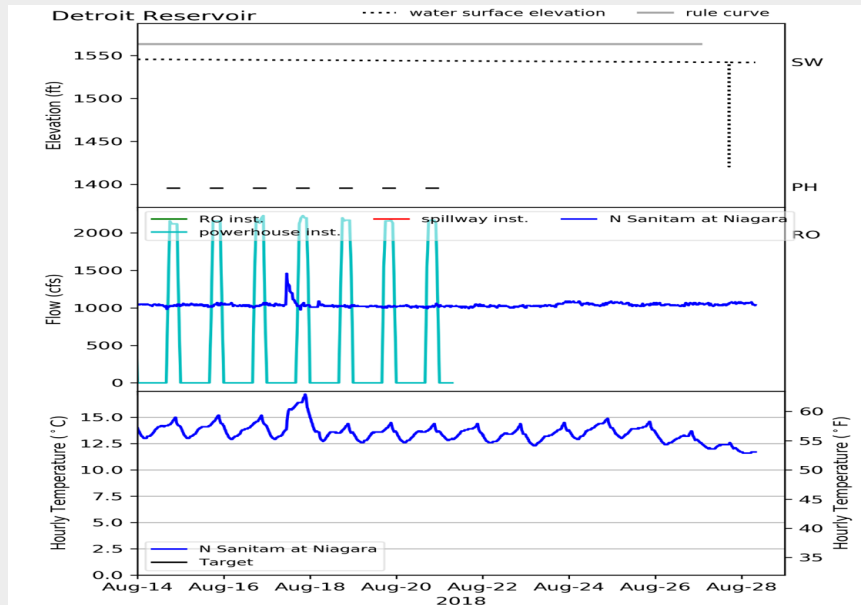
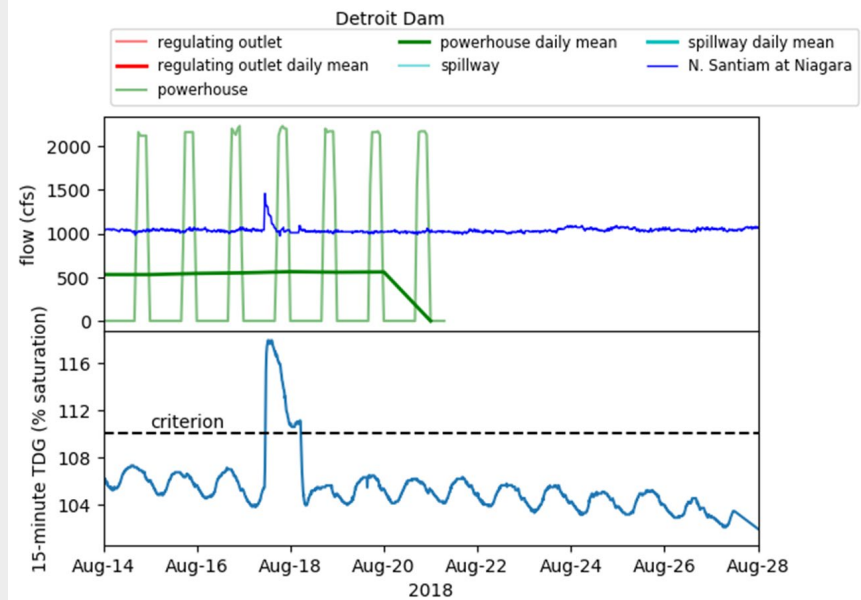
Detroit Dam, southeast of Salem, Ore., on the North Santiam River, provides a variety of functions including flood risk management and power production. However, it also blocks fish passage and the U.S. Army Corps of Engineers is in the process of building temperature control and fish passage at this site.

If feasible and more efficient to achieve both purposes through one construction project, the BiOp allows for this.

### Upcoming Public Meetings

The Corps will host three public information meetings to provide an overview of alternatives assessed to date to meet the project's purpose. View the alternatives analysis report [here](#). This is NOT a formal comment forum.

- August 7, 2018, 5:30-7:30 p.m., Stayton Community Center: 400 W Virginia Street, Stayton, OR 97383
- August 22, 2018, 5:30-7:30 p.m., Gates Fire Hall: 140 E Sorbin Street, Gates, OR 97346
- August 23, 2018, 5:30-7:30 p.m., Oregon Department of Fish and Wildlife Commission Room, 4034 Fairview Industrial Drive SE, Salem, OR 97302



# Pittsburgh District Water Quality Monitoring Network

- Funds the USGS to build, maintain, and store data for a network of GOES Water Quality stations
  - Provides valuable real-time data to evaluate health of lake projects
- Employs buoyed stations for continuous monitoring
  - Operate spring-fall each year
  - Turbidity, total dissolved gas, water temperature, dissolved oxygen, pH, conductivity, etc.
- <https://v2.wqdatalive.com/public/15>



# US Army Corps of Engineers

## Pittsburgh District Reservoir Temperature Monitoring Network

POWERED BY WQData LIVE

Wednesday, August 29th, 2018

Surface Sonde Depth (ft)	1.46
Surface pH	10.56
Surface pH mV	-242.8
Surface ORP (mV)	146
Surface Turbidity (NTU)	4.29
Surface Chlorophyll (ug/L)	15.8
Surface Chlorophyll RFU (RFU)	3.9
Surface BGA-Phycocyanin (ug/L)	0.890
Surface BGA-Phycocyanin RFU (RFU)	0.9
Surface ODOSat (%)	121.3
Surface ODO (mg/L)	9.63
13ft Temperature (C)	26.02
<b>13ft Sp Cond (uS/cm)</b>	<b>375</b>
13ft Depth (ft)	9.833
13ft pH	9.03
13ft pH mV	-135.1
13ft ORP (mV)	219
13ft Turbidity (NTU)	173.36
13ft Chlorophyll (ug/L)	23.1
13ft Chlorophyll RFU (RFU)	5.7
13ft BGA-Phycocyanin (ug/L)	1.270
13ft BGA-Phycocyanin RFU (RFU)	1.3
13ft ODOSat (%)	134.3

Berlin Surface Chlorophyll

Graph

Table

Berlin Surface Chlorophyll



Berlin Surface pH

Graph

Table

Berlin Surface pH



Berlin 13ft Sp Cond

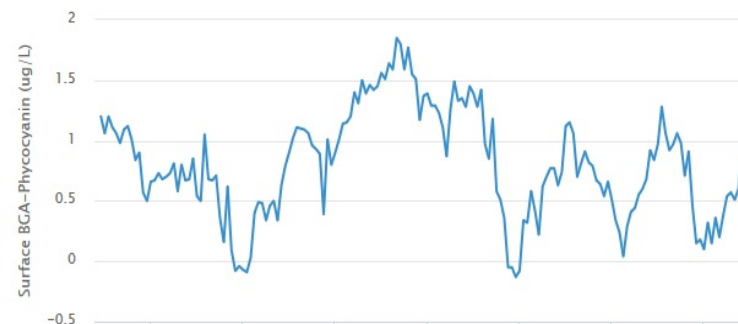


Berlin Surface BGA-Phycocyanin

Graph

Table

Berlin Surface BGA-Phycocyanin



Berlin 13ft Temperature




# National Weather Service, Interagency Fire Center and Forest Service

- Rapid deployed and permanent GOES transmitting stations
- Provide real-time data for monitoring fire danger
  - Weather Service Remote Automated Weather Stations (RAWS – behavior/predictive)
    - Average 5.8MM acres burned/year from ~51K fire events/year (2008 – 2017)
  - Forest Service Burned Area Emergency Response (BAER – post fire)
  - National Interagency Fire Center (NIFC) – Boise, ID
  - Weather information Management System – Nat'l Wildfire Coord. Grp.
    - Fire and Aviation Management software for fire weather and fuel modeling
  - Western Regional Climate Center – WRCC Reno, NV
- Provide real-time post-fire precipitation readings
  - Monitor for floods and landslides
- Interagency fire coordination and response
  - Forest Service, Natural Resources Conservation Service, Fish and Wildlife, Bureau of Land Management, U.S. Geological Survey, and National Weather Service




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## Remote Automatic Weather Stations (RAWS)



There are nearly 2,200 interagency Remote Automatic Weather Stations (RAWS) strategically located throughout the United States. These stations monitor the weather and provide weather data that assists land management agencies with a variety of projects such as monitoring air quality, rating fire danger, and providing information for research applications.



Most of the stations owned by the wildland fire agencies are placed in locations where they can monitor fire danger. RAWS units collect, store, and forward data to a computer system at the National Interagency Fire Center (NIFC) in Boise, Idaho, via the Geostationary Operational Environmental Satellite (GOES). The GOES is operated by the National Oceanic and Atmospheric Administration ([NOAA](#)). The data is automatically forwarded to several other computer systems including the Weather Information Management System (WIMS) and the Western Regional Climate Center ([WRCC](#)) in Reno, Nevada.

Fire managers use this data to predict fire behavior and monitor fuels; resource managers use the data to monitor environmental conditions. Locations of RAWS stations can be searched online courtesy of the Western Regional Climate Center.

<https://raws.nifc.gov/>



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FOREST SERVICE HOME » WWW.FS.FED.US » NATURALRESOURCES » WATERSHED » WO STAFF PROGRAM - BURNED AREA EMERGENCY RESPONSE BAER

### Watershed

- Overview
- Focus Areas & Initiatives
- Program Leaders
- Documents & Publications
- Tools
- Water Education
- Watershed Related Links

## Burned Area Emergency Response - BAER

**Background | [Wildland Fire Leadership Council](#)**

While many wildfires cause little damage to the land and pose few threats to fish, wildlife and people downstream, some fires create situations that require special efforts to prevent further problems after the fire. Loss of vegetation exposes soil to erosion; runoff may increase and cause flooding, sediments may move downstream and damage houses or fill reservoirs, and put endangered species and community water supplies at risk. The Forest Service Burned Area Emergency Response (BAER) program addresses these situations on Forest Service lands with the goal of guarding the safety of Forest visitors and employees and protecting Federal property, water quality, and critical natural or cultural resources from further damage after the fire is out. Information collected by the Forest Service BAER teams is shared with other Federal, State and local emergency response agencies so they can provide assistance to communities and private land owners who may also be affected by potential post-fire damage.

National BAER & Watershed Improvement Program Leader: [Penny Luehring](#)

**References**  
[2017 BAER Interim Directive](#): doc 170 KB  
[USDA Forest Service RMRS. Soil & Water Engineering Publications](#)

### Contact Us

US Forest Service  
1400 Independence Ave., SW  
Washington, D.C. 20250-1111  
(800) 832-1355

### National Headquarters

- Office of the Chief
- Chief Financial Officer
- Business Operations
- National Forest System
- Research and Development
- State and Private Forestry

<https://www.fs.fed.us/naturalresources/watershed/burnedareas.shtml>

policy and will enter into an agreement to install and maintain equipment only when other agencies have agreed to provide the 24-hour monitoring and take emergency action based on the data. The NWS and La Plata County Office of Emergency Preparedness agreed to these roles for the Missionary Ridge Fire. The NWS interprets the data and formulates hazard watches and warnings as required. The Office of Emergency Preparedness provides assignment of emergency response resources and coordinates response activities. Each party continues operating in their respective mission-specific roles. Butch Knowlton, La Plata County Emergency Manager, commented, "The network has been invaluable to emergency service personnel. By monitoring the network they know when and where to effectively commit manpower and resources. Information from the network assists water-system operators in determining basins affected by runoff allowing them time to close critical intakes. Even road crews and contract personnel monitor the system for safety. We don't know how we could have handled this situation without it."

A similar operational model to the model described for the Missionary Ridge Fire has been in use for almost 7 years in the Rapid Creek drainage above Rapid City, South Dakota, and recently (2002) similar models have been used following the Grizzly Gulch and Battle Creek Fires in South Dakota (table 1). The rapid-deployment network has been effective in providing warning to residents of Deadwood, South Dakota, where mudslides have resulted from precipitation in the burned areas of the

a series of field sensors, GOES/DOMSAT satellite transmitters, ground-readout delivery systems, and solar-power modules.

Examples of equipment used in the satellite-telemetered early-warning networks for the Missionary Ridge, Grizzly Gulch, and Battle Creek Fires are shown in figure 3 in burned areas. The field sensors collect data for a variety of hydrologic measurements selected by the BAER team to meet specific needs. Precipitation and stream stage are the most frequently acquired measurements, but other water-quality and quantity data can be collected. The data from the sensors are processed in a field data-collection platform (DCP) and transmitted to the GOES weather satellite. The processed GOES data are transmitted for local use to ground-readout stations by way of the DOMSAT satellite. The steps involved to deploy a network of this type are as follows:

1. Field sensor packages must be assembled according to the data needs of the BAER team and deployed at specified locations;
2. Satellite window assignments must be made at National Environmental Satellite Data and Information Service (NESDIS) for each field sensor station for data acquisition and delivery;
3. Data decoding must be completed for interpretation of the satellite data;
4. Responsibility for data monitoring and network maintenance must be assigned to the various support and interpretive personnel and agencies; and
5. Protocols defining required actions for specific data users must be developed based on data interpre-



A. Precipitation gage (instrument detail) used in burned area at Missionary Ridge Complex Fire.



B. Precipitation gage used in burned area at Grizzly Gulch Fire.



C. Precipitation gage used in burned area at Battle Creek Fire.

**Figure 3.** Examples of equipment used in rapid-deployment networks in burned areas at the Missionary Ridge, Grizzly Gulch, and Battle Creek Fires.





Post Wildfire Debris Flows, 2009 Station Fire, CA (USGS)



Fire Personnel Watch Wildfire at a Permanent RAWS Station (NIFC)

# Spectrum Preservation

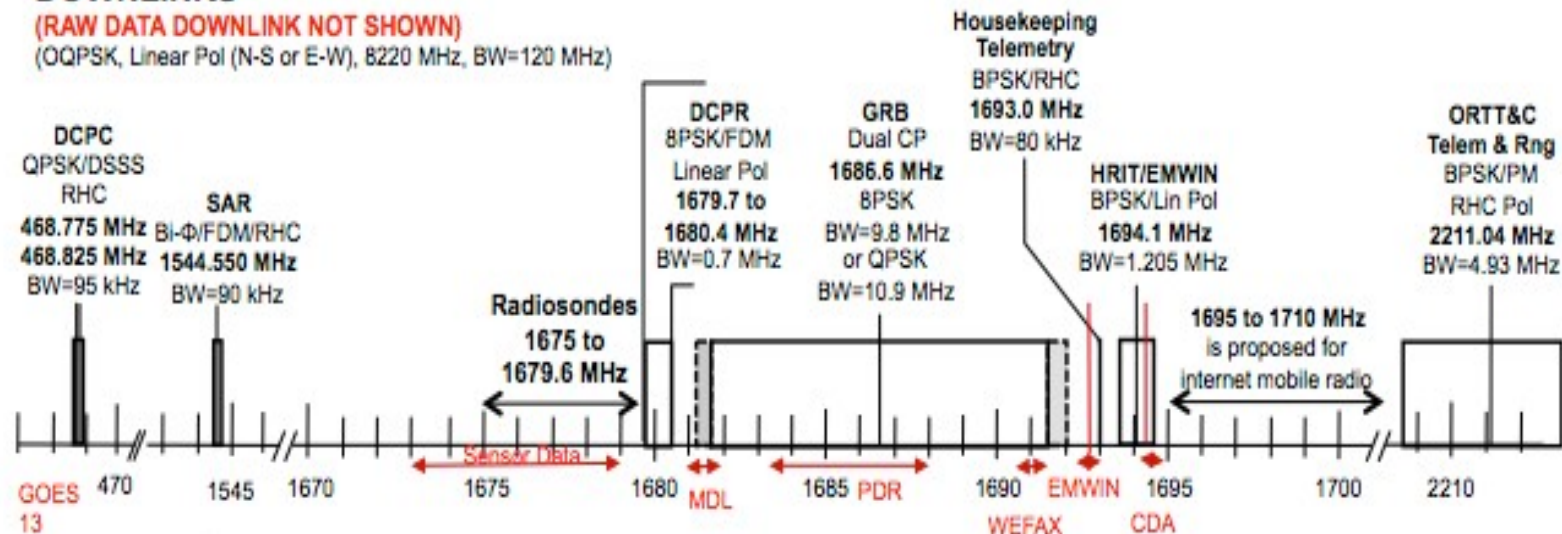
- GOES DCS channelized at 1679.7 – 1680.1 MHz
  - Autonomous collection insulates from terrestrial encumbrances
  - Reliable during storms and other Earth-events
  - Cost effective medium for distributed hydro-met network
- Desirable spectrum for terrestrial cellular network manufacturers; upper end auctioned
  - GOES HRIT @ 1694.1 while 1695 – 1710 reallocated for internet mobile radio
  - Commercial proposal to develop network within GOES spectrum at 1675 - 1680 MHz
    - Cross-country terrestrial cell-tower LTE network infrastructure
  - Terrestrial tower signal strength is billions of times more powerful than downlink signal “earth” strength
    - RF interference detected at various receive sites within exclusion zones
  - Impacts mission of aforementioned Federal, State, Local, and private agencies and organizations with hydro-met interests; includes Earth and Space weather products/imagery
  - Disrupted terrestrial GPS systems; proposing move to GOES allocation
  - Industry proposed GOES direct receive alternative: commercial terrestrial content delivery network
- Engaging users, Congress, agencies, etc. on RFI’s adverse impacts on protecting life, property, critical infrastructure, habitats, and economy
  - Whitepapers, briefings, symposia facilitated by STIWG, American Meteorological Society, National Hydrologic Warning Council, et. al.



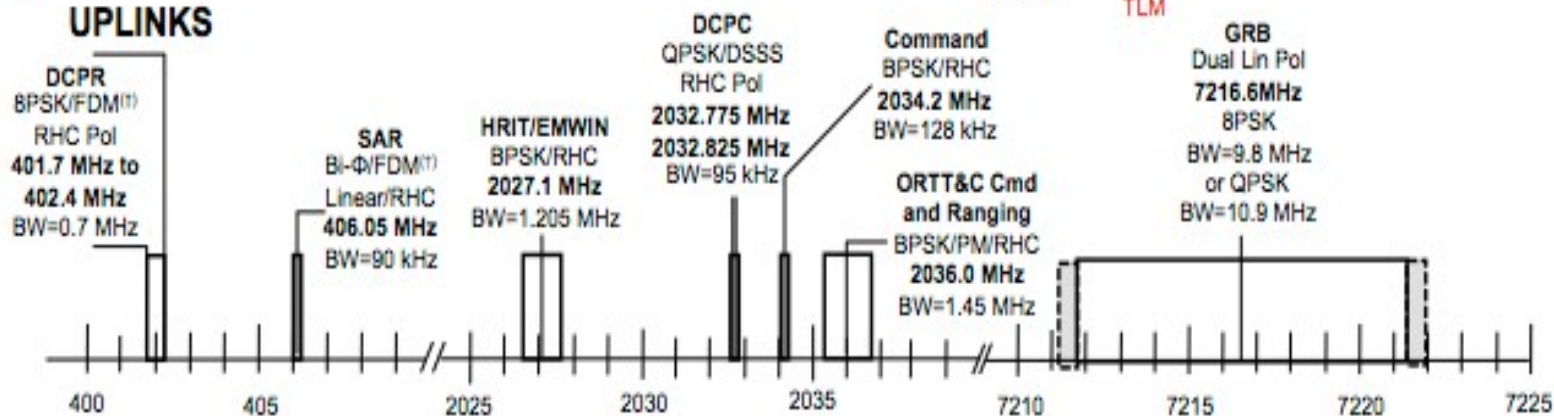
## DOWNLINKS

(RAW DATA DOWNLINK NOT SHOWN)

(OQPSK, Linear Pol (N-S or E-W), 8220 MHz, BW=120 MHz)

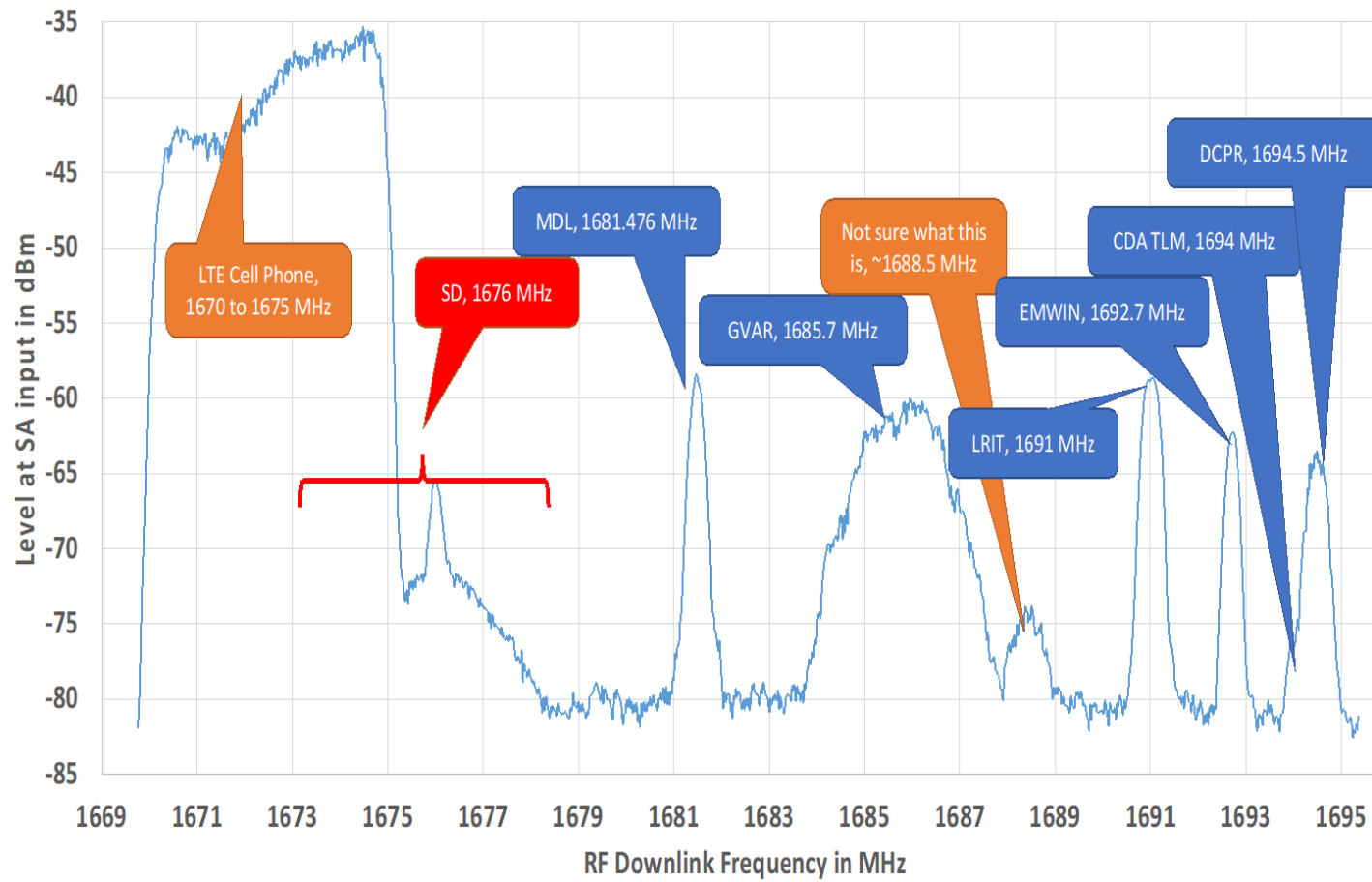


## UPLINKS



This image is a depiction of the GOES communication spectrum. The downlink graph (top) shows the 1675 – 1695 MHz band used by satellites to relay data to Earth receive ground stations (close proximity to the recently auctioned spectrum for wireless broadband (1695 – 1710 MHz) to the HRIT/EMWIN frequency at 1694.1 MHz. NPRM 19-116 proposes in-band operation of commercial radios at 1675 – 1680 MHz; on top of the GOES downlink at 1679.7 – 1680.1 MHz.

GOES East Spectrum Showing Cell Phone Signals near the Dallas-Fort Worth Airport, 29 Oct 2014

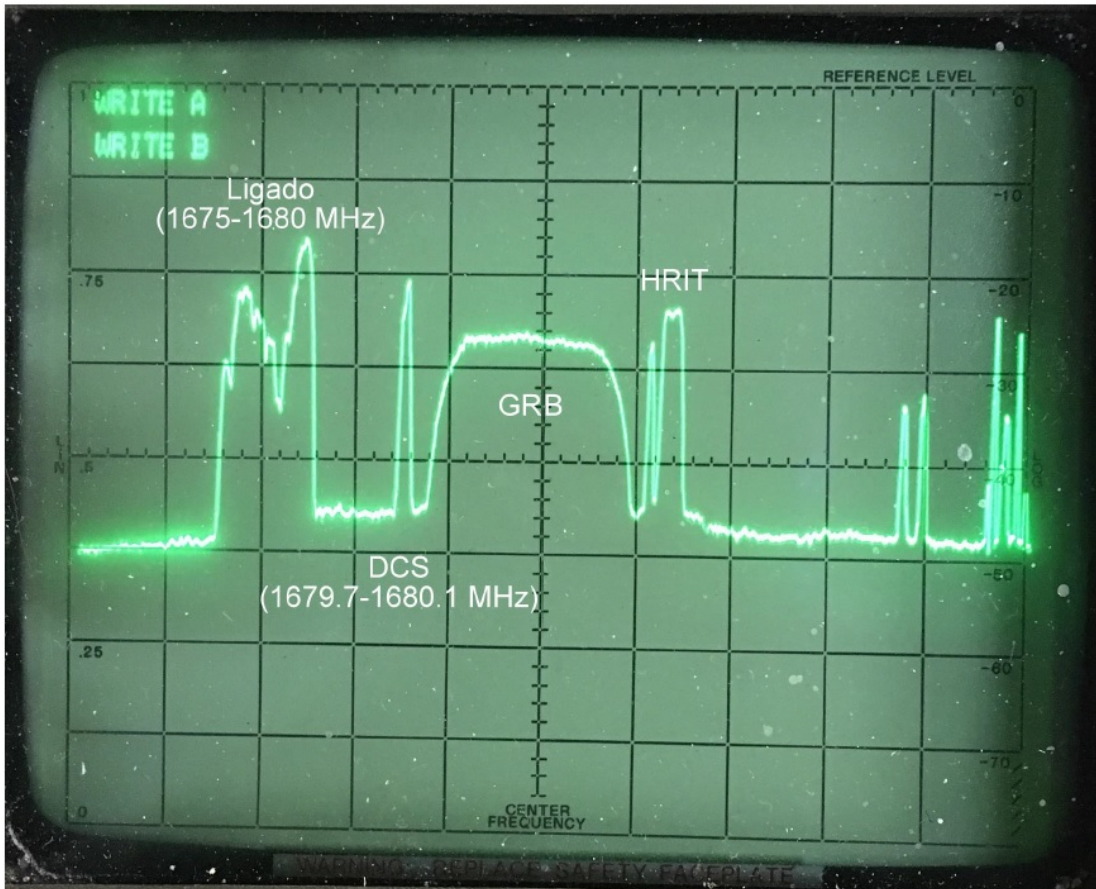


\*GOES-R now transmits at 1679.7 – 1680.4

\*GOES HRIT rebroadcast transmits at 1694.1 MHz

# Spectrum Preservation: In-band RF Intrusion

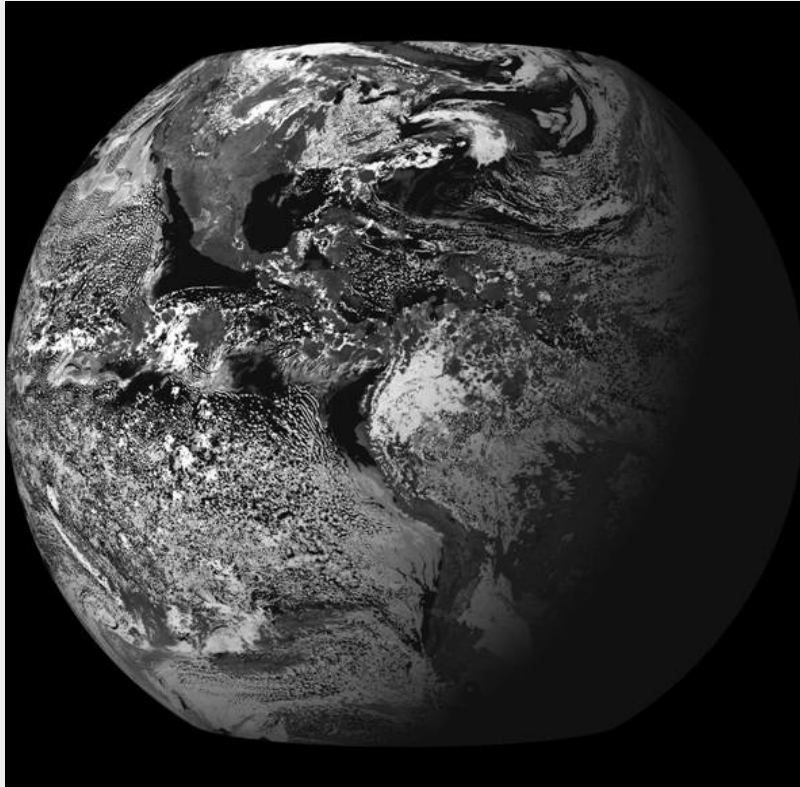
Reference Spectrum from 5M GOES-East (aka GOES-16) at DPCM



An example of emissions from a commercial cellular tower transmitter erected 6 miles from a GOES DCS DRGS (Direct Readout Ground Station). The estimated output power of this tower is less than half the 2,000 watts requested in **NPRM #19-116** yet already exceeds the received signal strength of the GOES DCS downlink at 1679.7 – 1680.1 MHz. In-band intrusions such as this threaten to impede the performance of incumbent GOES DCS systems.

\*GOES-R now transmits at 1679.7 – 1680.4

\*GOES HRIT rebroadcast transmits at 1694.1 MHz



Simulated GRB GOES-R Imager Full Disk  
(Mode 4, Band 1) Without Noise



Simulated GRB GOES-R Imager Full Disk (Mode  
4 Band 1) with noise injected at random point.  
Immediate catastrophic failure of the DVB-S2  
signal occurred



# GOES vs Terrestrial Storm Event Performance Synopsis

- Performance during Natural Disasters (Credit: Nathan Holcomb NOAA/NOS/COOPS)
  - NOS primarily uses Iridium and GOES to ingest data
    - Also employ IP modems and phone lines
  - Working to upgrade their data status reports to reflect where their data is coming from
  - Substantial decrease in the number messages coming from terrestrial connections immediately before, during and after hurricanes
  - Significant increase in GOES messages archived during storm events
  - GOES messages continued when IP modems and other terrestrial infrastructure dependent methods failed
    - GOES message count decreased as batteries failed; no electricity and/or damaged solar panels
  - Intends to use the statistics collected for further outreach to stress the need for essential data collection systems
  - Important to estimate impact had there been no data during storm events



# Highest Water Levels During Hurricane Irma



## Highest Water Levels (\*ft. above MHHW/Inundation)

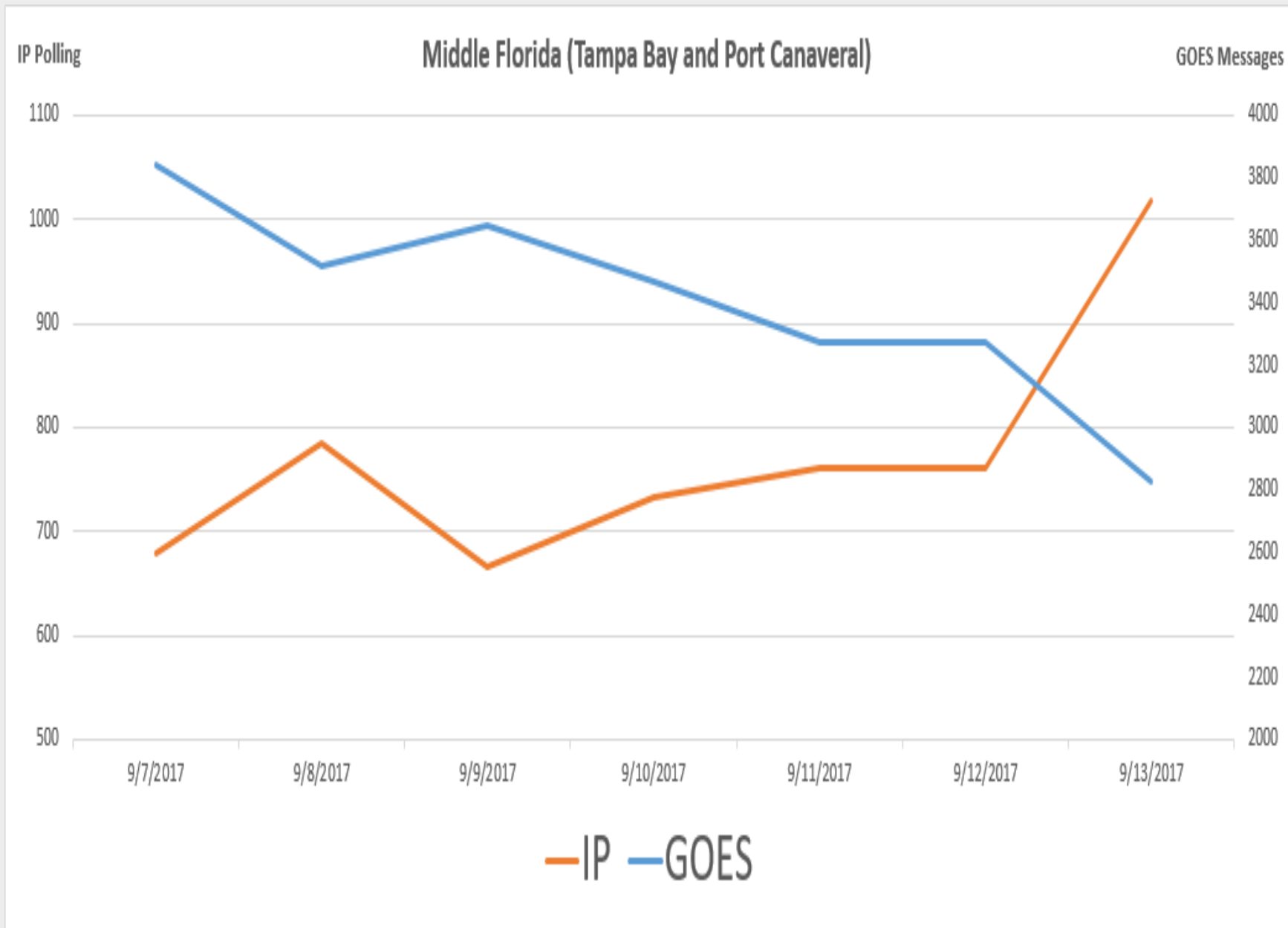
- I-295 Bridge, St. Johns River, FL (5.26 feet)
- Southbank Riverwalk, St. Johns River, FL (4.94 feet)
- Fort Pulaski (Savannah), GA (4.73 feet)
- Naples, FL (4.25 feet)
- Charleston, SC (4.15 feet)
- Virginia Key (Miami), FL (3.66 feet)

- Excessive rainfall in addition to storm surge may have contributed to elevated water levels within St. Johns River, FL.

- As Irma moved north across the state, water levels along the Gulf coast of Florida dropped significantly, reaching 3 to 6 feet below normal low tide levels ahead of the storm

- If verified, water levels at Virginia Key, FL exceeded peak water levels observed during Hurricane Wilma (2005).

\*Mean Higher High Water (MHHW) is defined as the average daily highest tide. Inundation typically begins when water levels reach above MHHW. These values are based on preliminary observed water levels from NOAA and partner tide stations.



Prior to Hurricane Irma (07-Sep-2017), NOS manually requested network DCP messages from platforms located in Tampa Bay and Port Canaveral to test system redundancy which caused the number of GOES messages stored to decrease prior to Irma's arrival. The number of IP messages began to decrease in number on 08-Sep-2017 as the storm arrived and gradually resumed as infrastructure was restored through 12-Sep-2017. GOES transmissions continued uninterrupted and compensated for the outage.

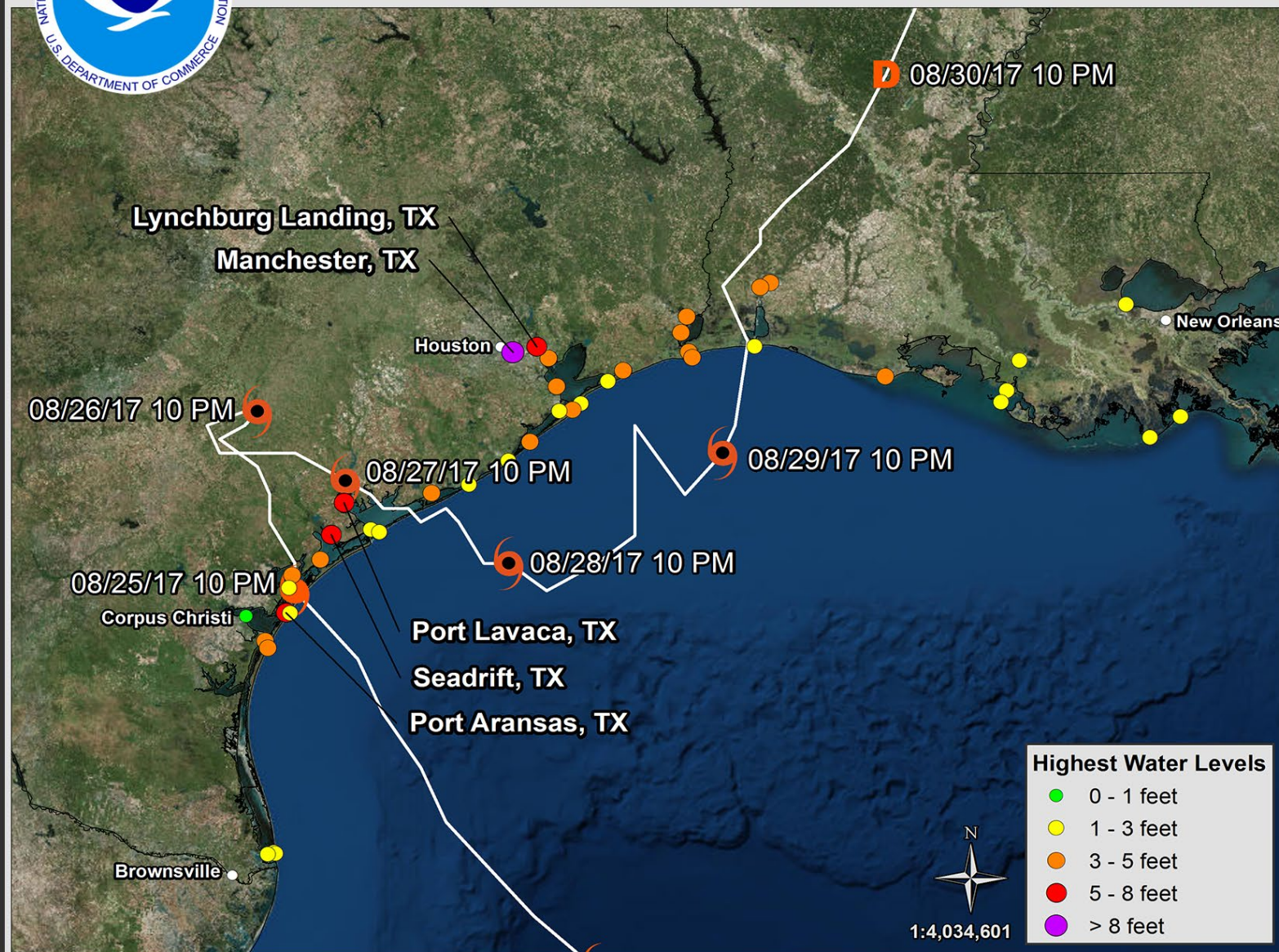
Note: GOES transmissions were stopped at some stations beginning on 12-Sep-2017, after the storm passed, until their damaged solar panels were replaced and/or electricity restored providing power to recharge batteries.





# Highest Water Levels During Hurricane Harvey

As of 8/31/17



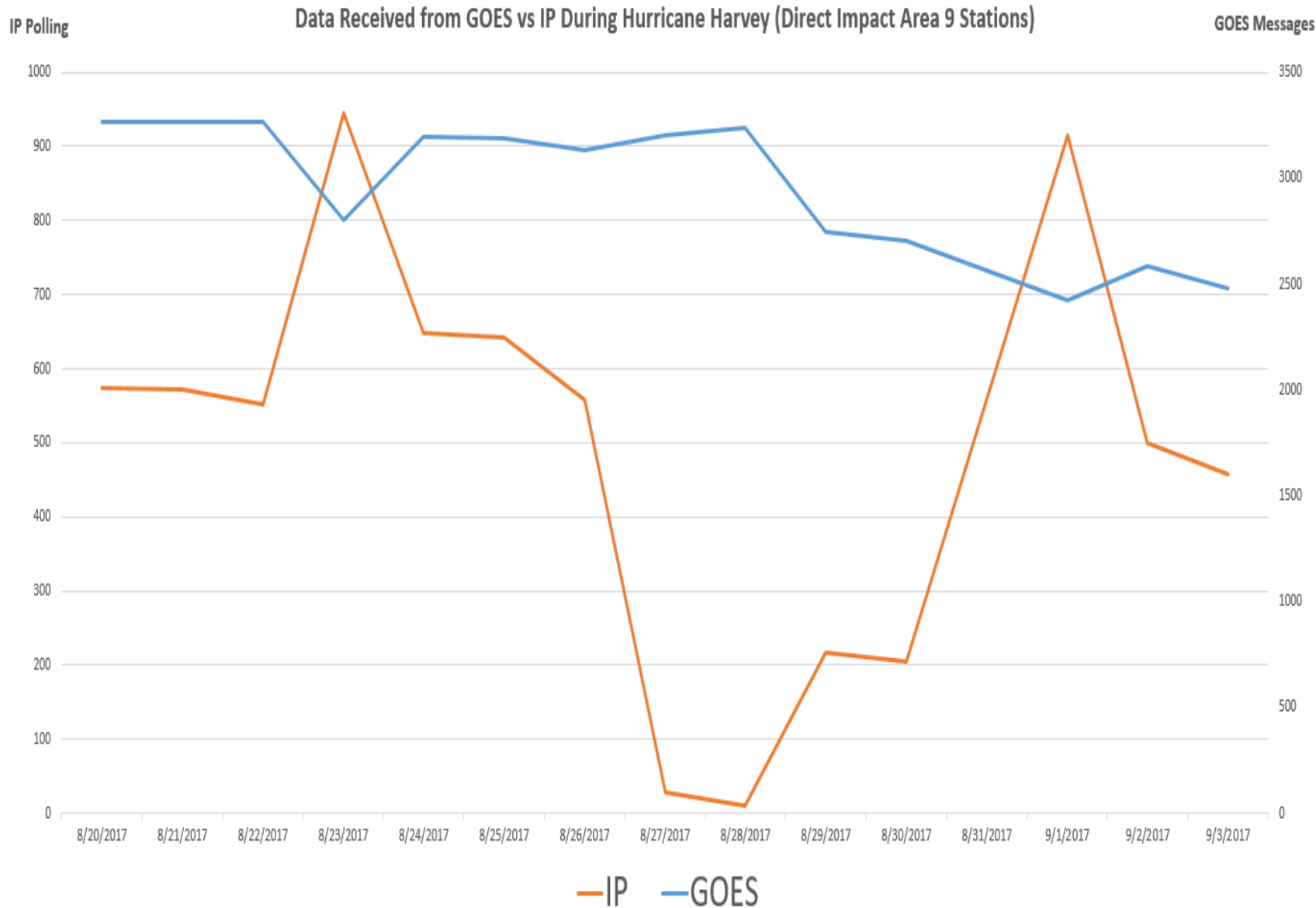
## Highest Water Levels (\*ft. above MHHW/inundation)

- Manchester, TX  
(10.35 feet)
- Lynchburg Landing, TX  
(7.27 feet)
- Port Lavaca, TX  
(6.71 feet)
- Seadrift, TX  
(5.52 feet)
- Port Aransas, TX  
(5.21 feet)

*These values include storm surge, rainfall runoff, waves, and other non-tidal influences. Some water levels in upper Galveston Bay near Houston are affected by excessive rainfall runoff. This graphic will be updated as the storm continues.*

*\*Mean Higher High Water (MHHW) is defined as the average daily highest tide. Inundation typically begins when water levels reach above MHHW. These values are based on preliminary observed water levels from NOAA and partner tide stations.*

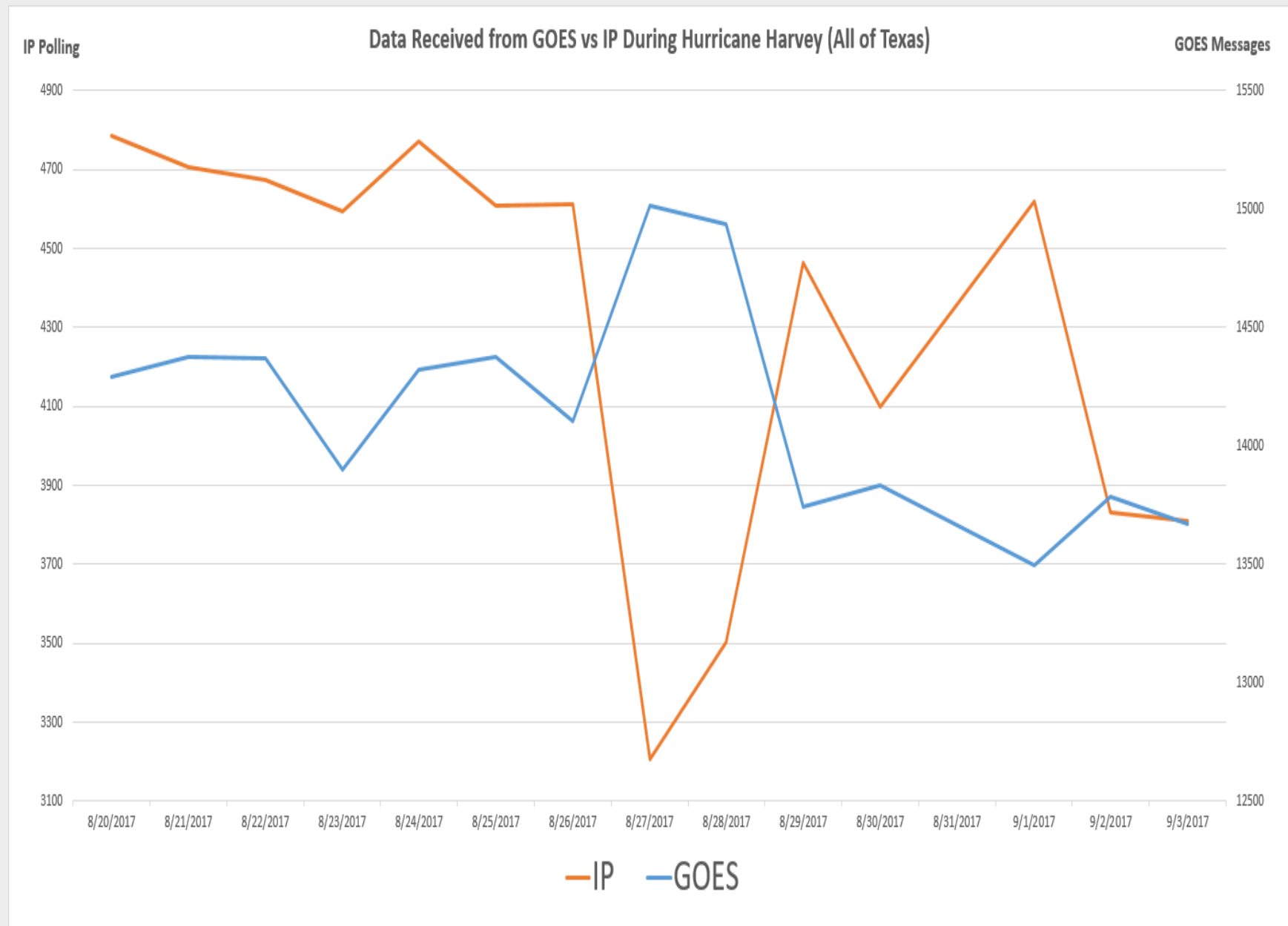




During Hurricane Harvey, network DCP message volume from platforms located on the Texas Gulf Coast area began to decrease on 24-Aug-2017; **99% IP message loss rate** occurred by 28-Aug-2017 after Harvey's arrival. GOES transmissions continued uninterrupted throughout the duration of the storm.

Network DCP message retrieval did not resume normal operation until infrastructure was restored around 30-Aug-2017. Beginning 22-Aug-2017, prior to Harvey's arrival, redundancy checks were performed; reflected by the spike in IP messages received that day and inversion with GOES message counts.

Note: GOES transmissions were stopped at some stations beginning on 30-Sep-2017, after the storm passed, until their damaged solar panels were replaced and/or electricity restored providing power to recharge batteries.



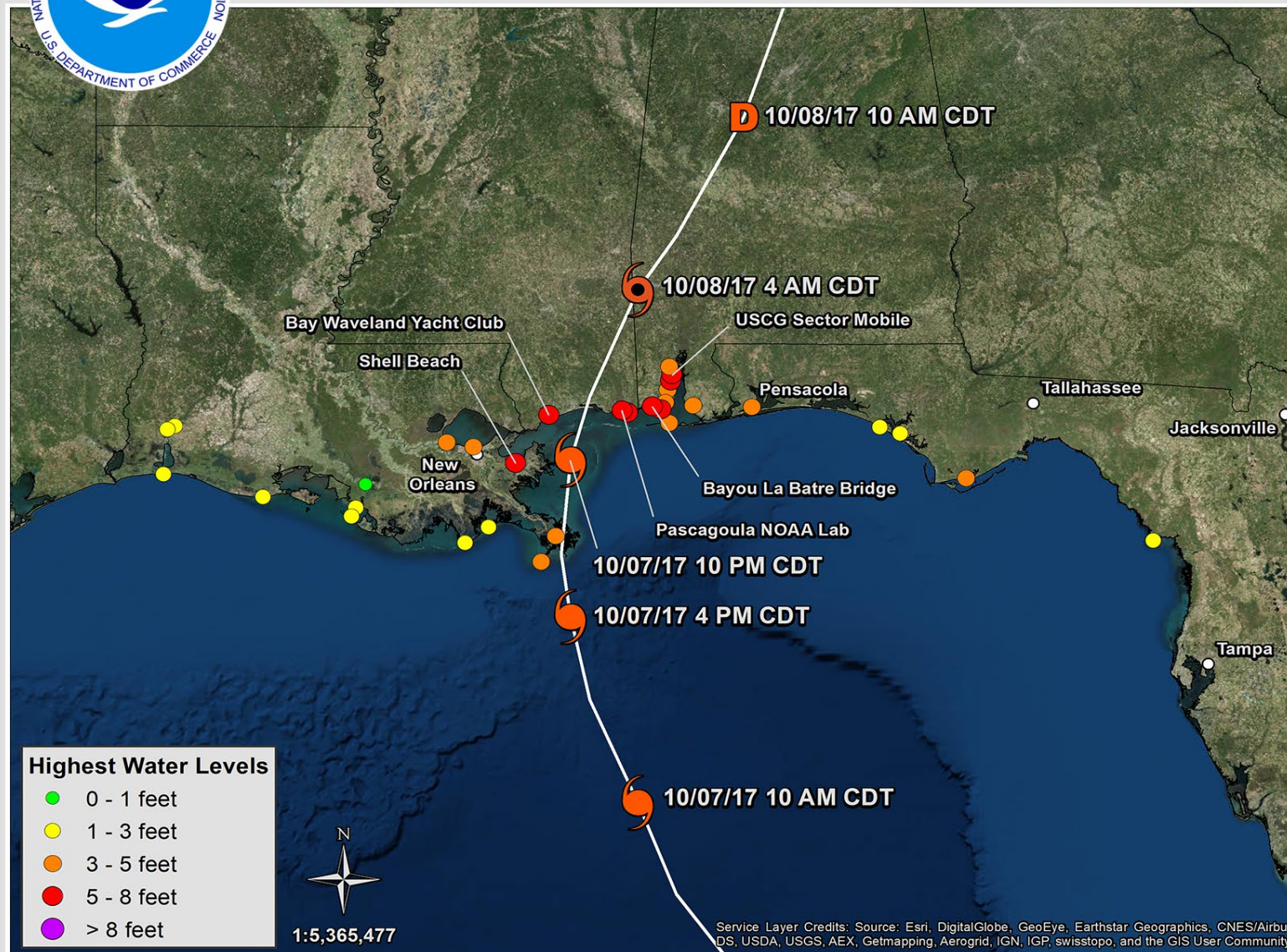
During Hurricane Harvey, network DCP message counts throughout the state of Texas decreased by nearly 30% on 26-Aug-2017 and did not approach pre-hurricane performance until 29-Aug-2017. GOES platforms continued transmitting during the storm event and compensated for the outage.

Note: GOES transmissions were stopped at some stations on 30-Aug-2017, after the storm passed, until their damaged solar panels were replaced and/or electricity restored providing power to recharge batteries.





# Highest Water Levels During Hurricane Nate



## Highest Water Levels (\*ft. above MHHW/Inundation)

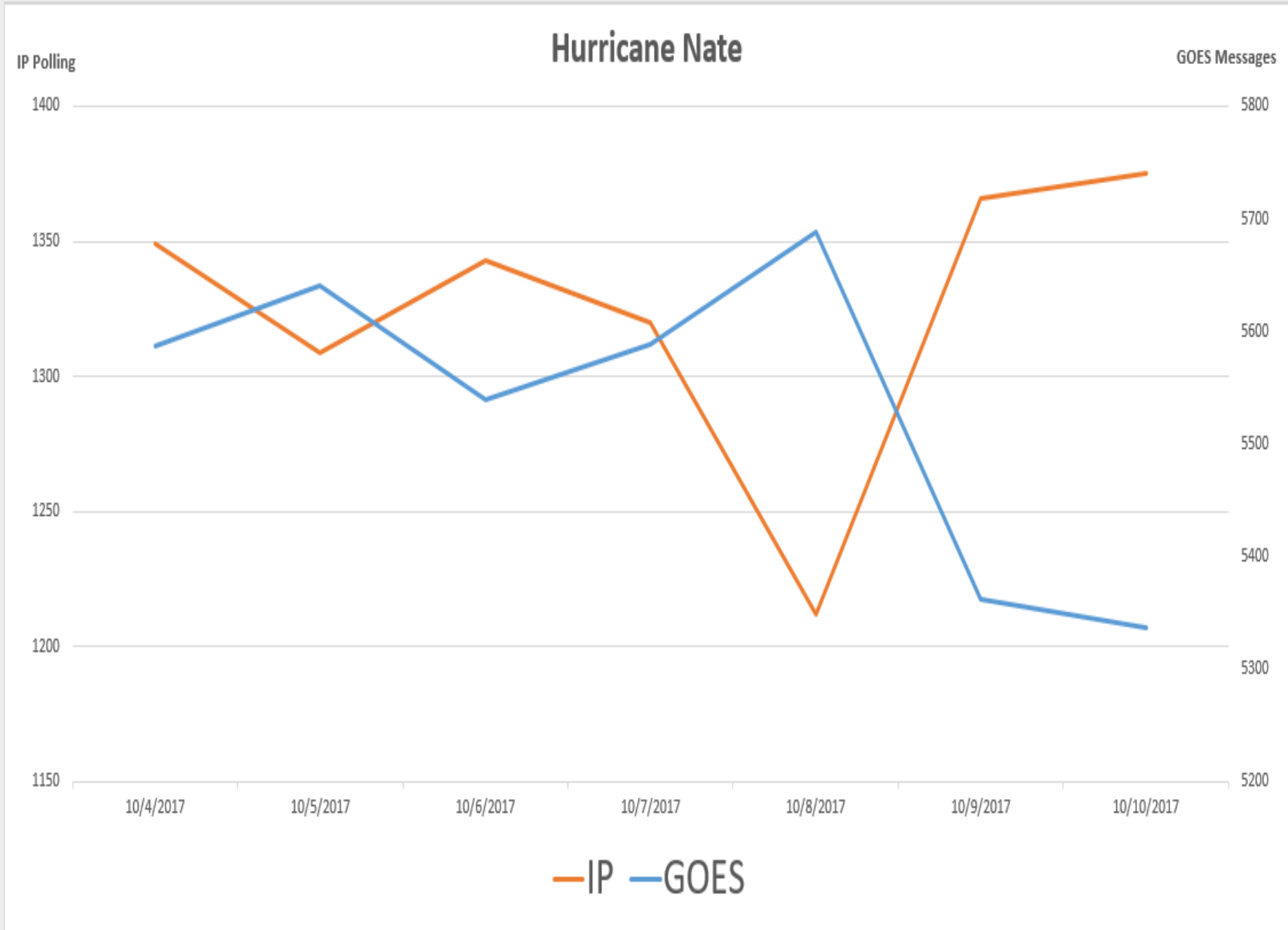
- Pascagoula NOAA Lab, MS (6.2 feet)
- Bayou La Batre Bridge, AL (5.9 feet)
- Bay Waveland Yacht Club, MS (5.6 feet)
- USCG Sector Mobile, AL (5.4 feet)
- Mobile State Docks, AL (5.1 feet)
- Shell Beach, LA (5.0 feet)

- Numerous stations along the southeast Mississippi and within Mobile Bay eclipsed record high water levels set during Hurricanes Gustav (2008) and Isaac (2012) including Pascagoula NOAA Lab, USCg Sector Mobile, and Mobile State Docks.

\*Mean Higher High Water (MHHW) is defined as the average daily highest tide. Inundation typically begins when water levels reach above MHHW.

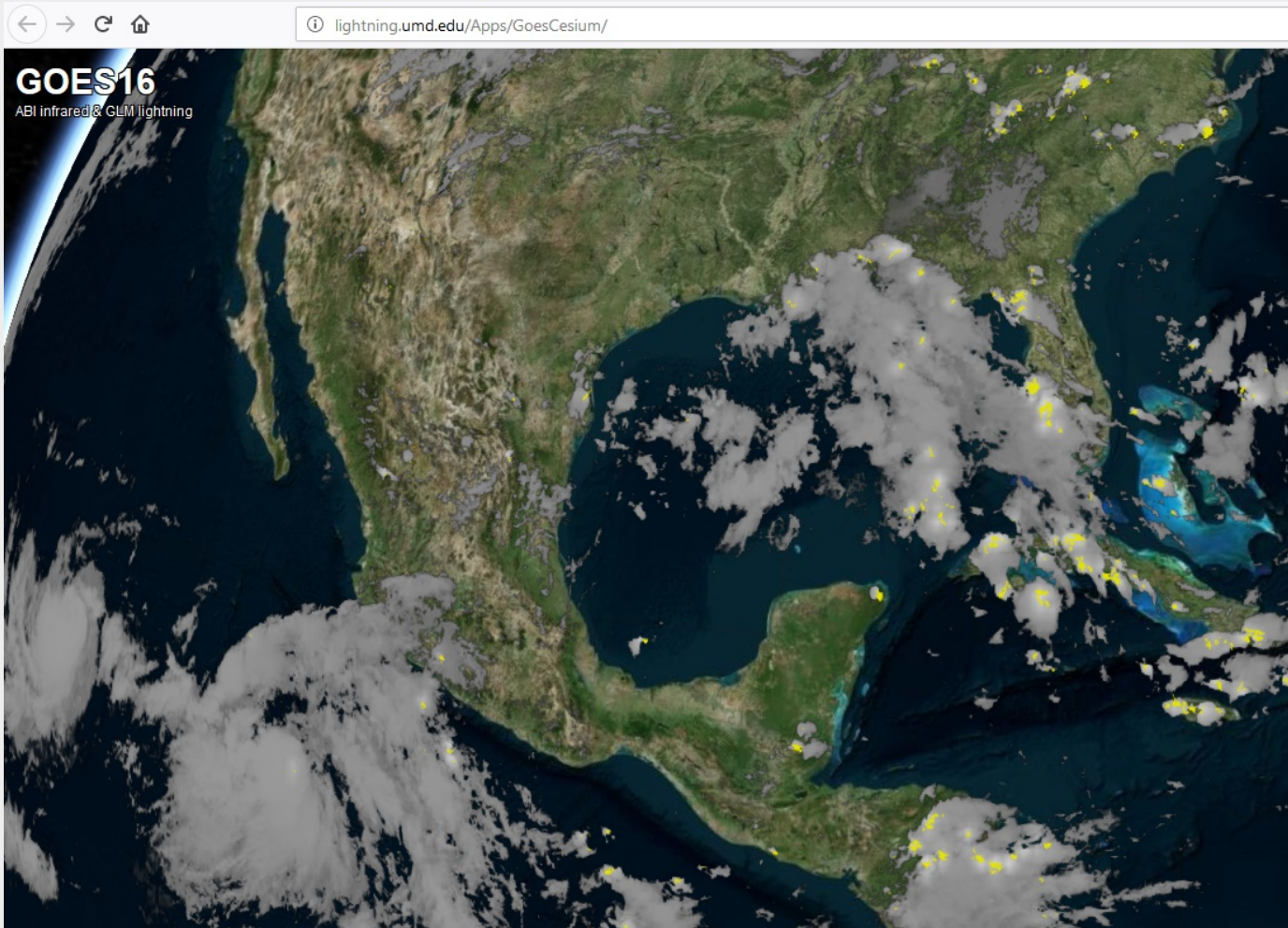
\*These values are based on preliminary observed water levels from NOAA and partner tide stations.





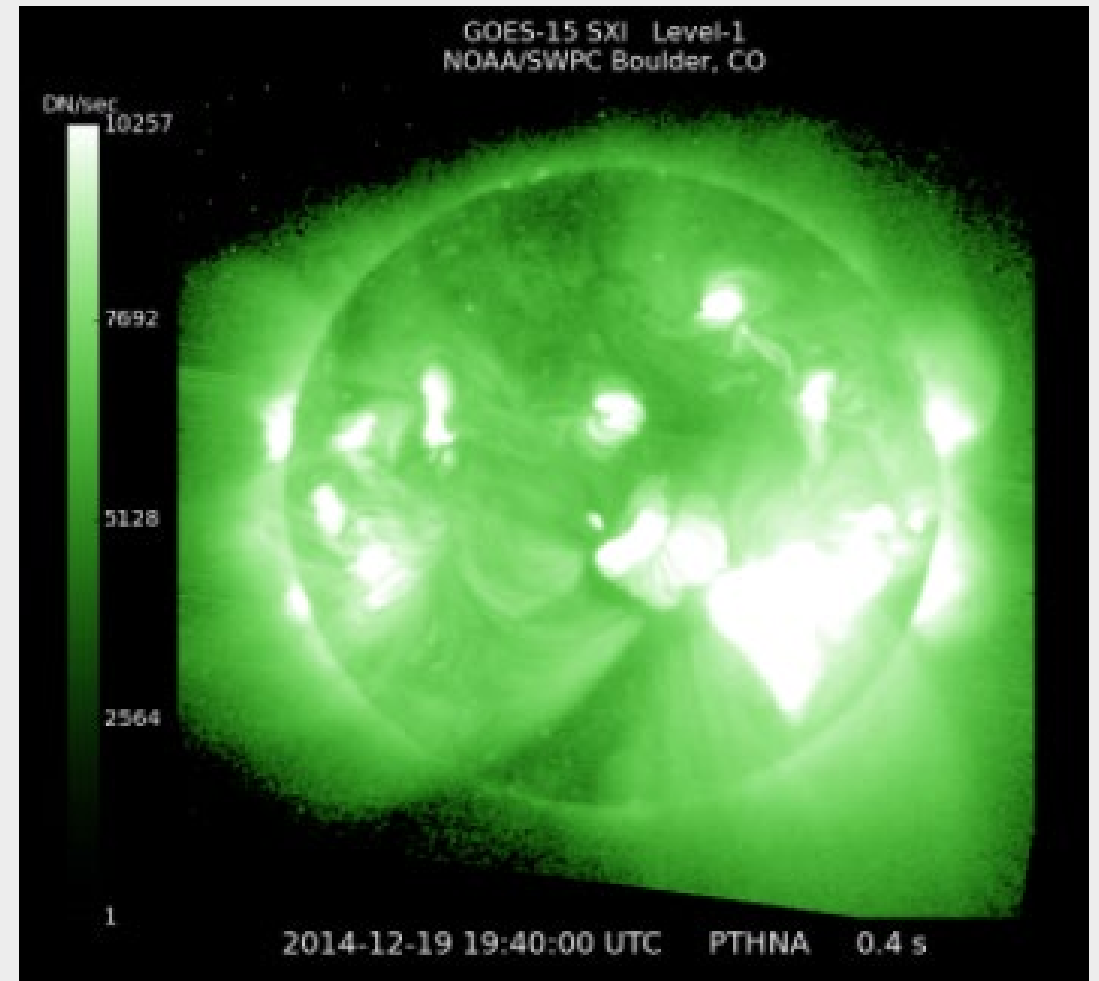
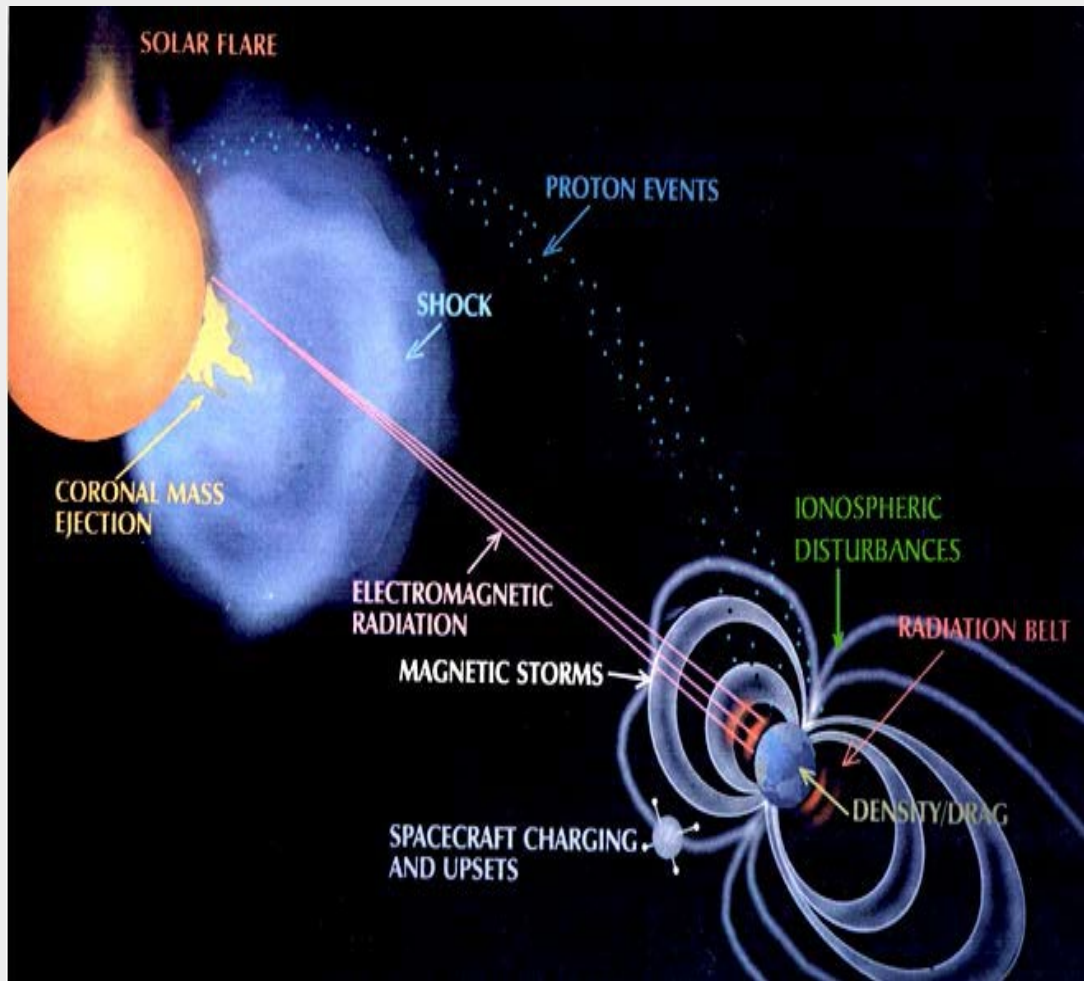
During Hurricane Nate, network DCP messages from platforms began to decrease in number on 07-Oct-2017 and resumed more normal operation on 09-Oct-2017. GOES transmissions continued uninterrupted and compensated for the outage. The increase in IP messages on 06-Oct-2017 is due to pre-storm redundancy checks.

Note: GOES transmissions were stopped at some stations on 08-Oct-2017, after the storm passed, until their damaged solar panels were replaced and/or electricity restored providing power to recharge batteries.



By combining various wavelengths in Advanced Baseline Imager products with the lightning flash detection from the Geostationary Lightning Mapper, GOES-R can provide a “radar-like” substitute over ocean areas for aviation use.

When Hurricane Maria destroyed the radar used for weather in Puerto Rico, GOES-16’s data and OPC were used to temporarily substitute for the lack of ground radar coverage in Puerto Rico.



GOES Satellites monitor Near-Earth space environment driven by solar events: GOES Electron Flux, GOES Magnetometer, GOES Proton Flux, GOES Solar X-ray Imager, and GOES X-ray Flux.



# Spectrum Preservation Path Forward

- Interagency efforts to investigate radio frequency intrusion, interference, and mitigation
  - On-site RF analysis
  - Determine spectral compatibility between incumbent Earth stations and proposed commercial radios within the 1675 – 1680 MHz spectrum
  - Determine baseline of existing receive systems
  - Determine viability of spectrum sharing
  - Determine if there exist mitigation measures protect incumbent receive stations
  - Implement monitoring and reporting measures
  - Investigate viable/reasonable RFI protection
  - Report findings and provide impact assessment

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# End

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